

THE BOOK OF -3D PRINTING- MODELING, FINISHING & MORE

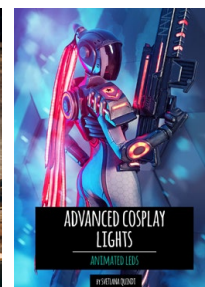
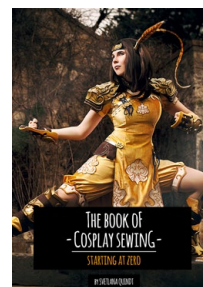
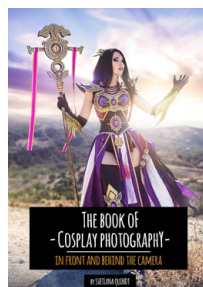
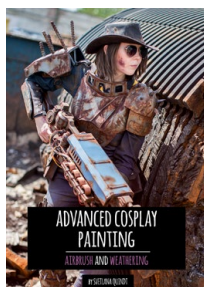
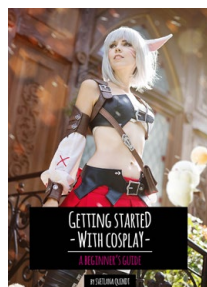


SVETLANA QUINDT
BENJAMIN SCHWARZ

GO MAKE SOMETHING!

Please visit my website and check out my other books and patterns:

www.kamucosplay.com



In the past, makers needed a fully equipped workshop and all kinds of tools and materials to create a single costume piece. A 3D printer, however, allows you to create accessories, props and even life sized body armor only with a single tool! This means we don't necessarily need huge amounts of space, expensive tools and all kinds of different materials anymore. Sounds pretty sweet, right?

Aside from this new freedom, 3D prints are very sturdy and allow you to build things with millimeter accuracy - just right for crazy crafting perfectionists! In addition, 3D modeling (which I will also touch on in this book), lets you create everything you can imagine: from tiny buttons that are impossible to find in any fabric shop, to fancy looking belt buckles, pretty crowns, and even crazy light up swords or full body armor. Just load up your model, start your printer and take a nap while the machine is creating something awesome!

After the initial investment of buying a machine, printing something with it can also be very affordable and might actually take you less time than working with any other material.

While all of this sounds very exciting, I know that 3D printing may seem a bit intimidating at first. You probably would not have bought this book otherwise, right? Don't worry though, I'll make sure your first steps into this new hobby will be fun and easy to understand. Getting into it might actually turn out to be one of the most useful skills you've ever learned! I will do my best to answer all your questions and show you everything you need to know. So, let the adventure begin!

Author's note: this book was written in equal parts by myself, Svetlana, and my husband Benni. Since it would be super distracting to constantly change the author throughout, we will - for the sake of this book - temporarily merge into a single person, Svenni! (Yeah, sounds better than Betlana.) This just makes writing in the "I" form a lot easier. If you still want to know who wrote which part, just assume everything that sounds clever was written by me, then edited by Benni, rewritten by me again and finished by Benni. We're a single person now. Fusion HA!



ABOUT KAMUI COSPLAY

We're Svetlana and Benni but most of you know us as Kamui Cosplay. If you're into making costumes, chances are you've already stumbled upon one of our videos, tutorials or books before. We consider ourselves very lucky to be able to make our living by helping creative people like you with their crafting dreams. We're humbled by all the love you send our way and try to give back as much as we can.

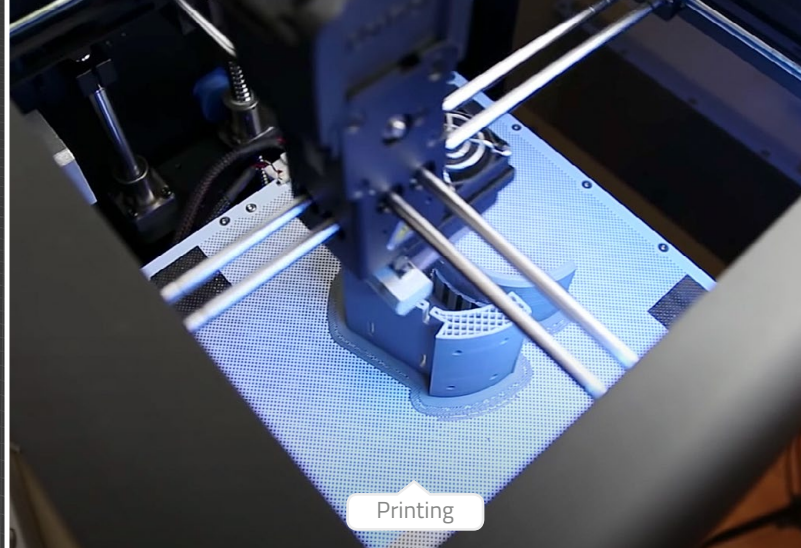
Thank you for your support by buying this book! Hopefully, you will find it helpful and inspirational!

Content

About this book	02
Why use 3D printing?	04
3D printer overview	06
Finding models to print	10
Introduction to Fusion 360	12
Introduction to Blender	14
Printing settings	16
Finishing raw prints	20
3D body scans	28
Working with Pepakura	30
Work examples:	
Fallout 4 - Pip-Boy	36
FFXIV Monk - Accessories	38
Fallout 4 - Pipe Revolver	40
Horizon Zero Dawn - Aloy	42



Downloaded 3D Model



Printing



Assembly



Finished Paint Job

What is 3D printing and why is it great?

3D printing is a process that builds a three dimensional object based on a 3D model, traditionally by adding layer after layer of material. Most home 3D printers use melted plastic or liquid resin. So, instead of creating a costume piece completely by hand out of foam, Worbla, or clay, a 3D printer is just a tool to build something in a different way. Using 3D printing, you are able to turn a 3D model that you've designed yourself, commissioned, or downloaded from the Internet into a real-life object. This simply gives you more options to create a costume or prop piece. Just like a sewing or embroidery machine can give you more options when working with fabric.

So, what's the best reason to get into 3D printing? Traditional cosplay materials often narrow your skills simply by their quality. Adding details with Worbla is always limited to the thickness and structure of the sheets and foam armor will always stay a little bit soft and wobbly. 3D printing however, gives you the ability to create one or multiple copies of a piece that is far more durable, rigid and which has a much higher level of detail. Up to a certain point it's surely possible to create the same look with your favorite materials as well,

but 3D printing simply makes the same process much easier. It's also possible to create the Pip-Boy **[upper images]** for my Fallout 4 costume out of foam of course. But I strongly doubt that even I would be able to achieve the same quality and level of detail with EVA foam or Worbla.

Getting a strong and rigid armor was actually the main reason why I decided to use 3D printing for my Aloy costume **[image 1 next page]**. I didn't doubt my ability to include all tiny, technical

details in the armor the traditional way, but I simply wanted to use a material that was stronger than foam or Worbla.

In addition, I was able to work on other costume pieces while my 3D printer was busy creating the armor parts for me. Yes, depending on the model, size and complexity it can take hours if not days for a piece to be printed, but why not use this free time to work on a wig or a prop instead, right?

Luckily, to use 3D printing, you don't have to know anything about 3D modeling nor do you need to own a printer yourself. There are both plenty of websites where you can find pre-made models as well as artists who offer their 3D modeling skills for commissions. My Pip-Boy was actually also just a model I downloaded from a website (more on that later)! In addition, you can even find printing services that let you upload any 3D model, select the material, and have it printed and shipped directly to your home. Using such an online service is probably the cheapest and easiest way to get what you want, especially when

you only need a single print of something. No need to buy a printer just for that! It is also definitely worth checking your local library or maker space to find a printer that you can use for an even smaller fee!

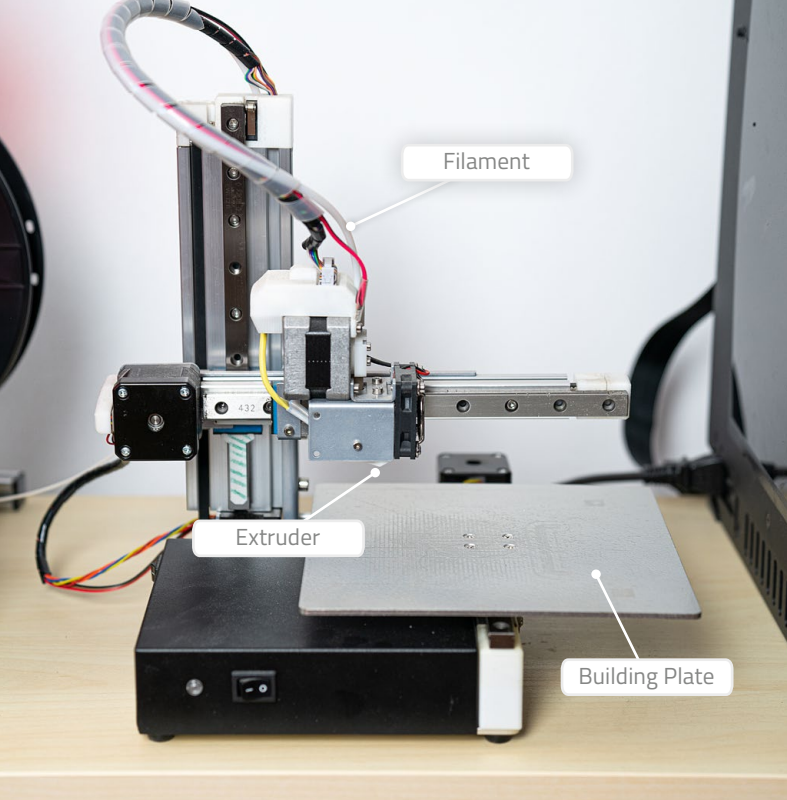
If you plan on printing more often though, I think it may be time to get your own machine.

Knowing a thing or two about 3D modeling also has many other awesome benefits besides being able to make your own models. I often use the 3D model of a costume piece to create

patterns to use with EVA foam or Worbla. The helmet and breastplate for my Star Wars costume shown below [2], for example, were completely made out of lightweight EVA foam. The patterns for these pieces however, were made from a 3D models with a technique called Pepakura. I'll explain this in more detail a little later in this book.

So you see, no matter if you download your models and have them shipped to you, or if you make your own models and print them yourself, 3D printing will open up a whole new world of crafting possibilities. NOTHING CAN STOP US!



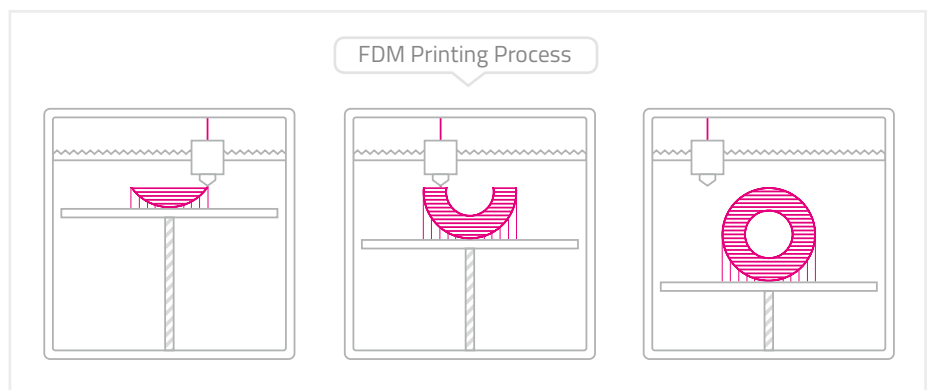


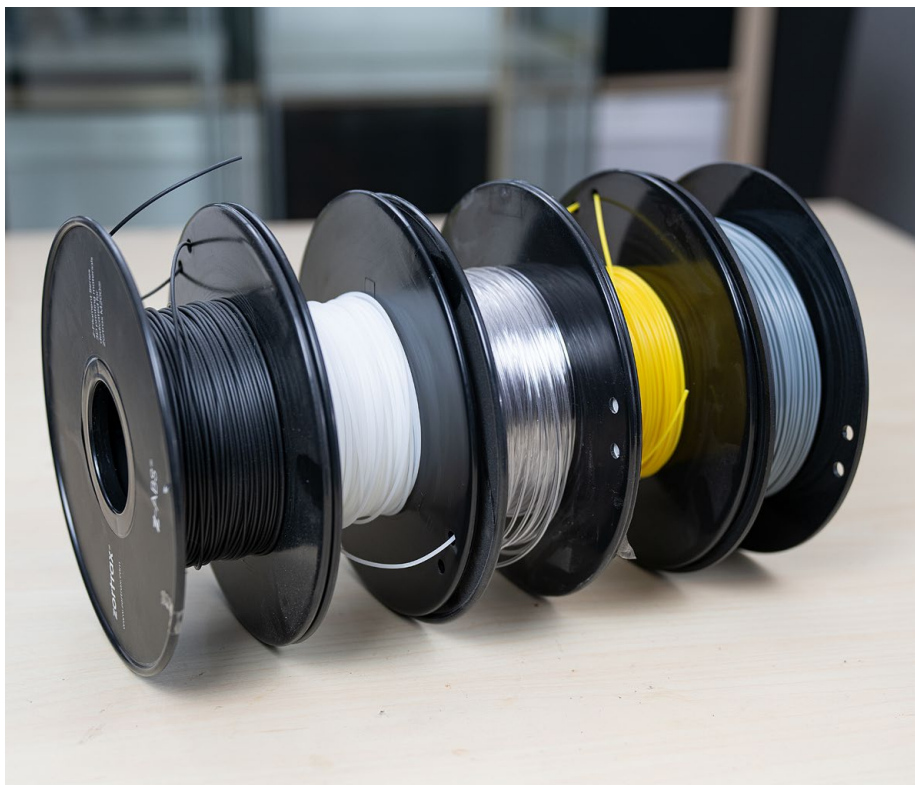
How 3D printing works

If you've never worked with a 3D printer before, it's quite easy to get lost in all the different machines, materials, printing techniques and 3D modeling software. So, let me quickly give you an overview of the most common printer types and some basic knowledge that will hopefully help you find your personal favorite. There are far more technologies out there, but in this book, I want to focus on two types of printers that I think are the most useful for crafters.

FDM printers

When you think of a 3D printer you will probably have a FDM machine in mind first. FDM stands for "Fused Deposition Modeling" (yeah, I don't really understand it either). It basically works like this: a plastic filament (in the shape of long spaghetti rolled on to a spool) gets heated and squeezed through a hot nozzle (also called an extruder) onto a building plate. Think of it as a really small hot glue gun that is controlled by a robot. The machine pushes the melted material through the hot nozzle and moves it around based on a series of instructions (your 3D model). After one layer is done, it moves up a tiny bit and continues. This way your 3D model is built up slice after slice until it is finished. The "resolution" decides how thin your layers are and therefore how fine your model looks. Thinner layers (higher resolutions) mean smaller visible layer lines, which result in a smoother surface, cleaner details, and less time required for finishing. Here you can see an example of two different resolutions printed on the same machine.



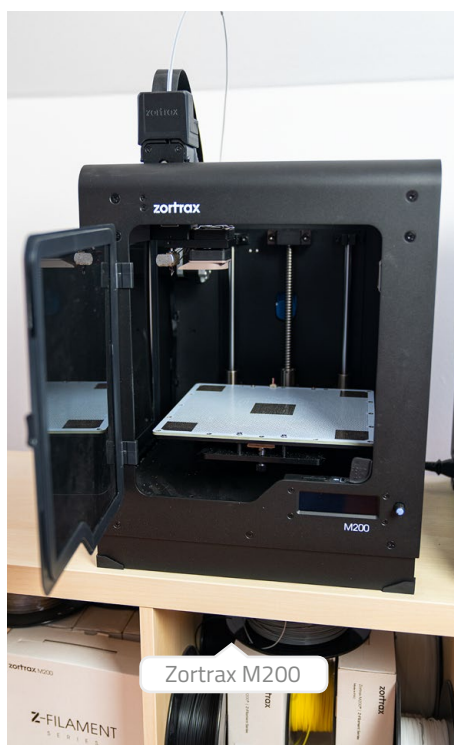


Print materials (filaments)

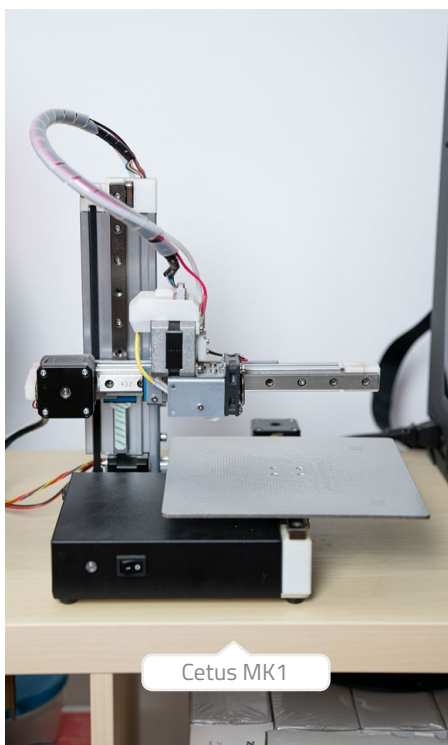
FDM printers can print in a variety of materials but the two most common are: PLA and ABS.

PLA is a plastic that requires a pretty low melting point for printing (~180°C). Therefore PLA machines are usually a bit cheaper, since their components have fewer requirements. These machines can print in an open case with fewer parts and on a non-heated building plate. Finished prints however also deform more easily in direct sunlight (at around 65°C).

ABS on the other hand is a little bit more tricky. The printing temperature has to be higher (~230°C) and it needs to be printed on a heated building plate in a closed off machine (to keep the temperature constant). However the material is easier to sand and glue. Both ABS and PLA cost about the same (~20USD for 1kg) and can be equally used for 3D printing costume pieces. So it's up to you which one you prefer! My personal favorite is ABS though.



Zortrax M200



Cetus MK1

My FDM printers

Now you might be curious about which 3D printers I use, right? Most of my projects are printed on a Zortrax M200. It's an FDM printer with a relatively high resolution (up to 0.09mm/layer) and a decent-sized build volume (20x20x18cm). Their supplier offers great customer support, has a large and creative community, and delivers plug-and-play machines that are just waiting for their first printing orders. My main reason to buy the Zortrax M200 was its high printing quality though. Furthermore, we even got a second machine of the same type to be able to work faster. I mainly print ABS on it and not much else.

In addition to these two printers, I also own a Tiertime Cetus3D MK1, which was a very affordable PLA printer (300USD at the time I bought it). To keep the price low, the printer needs to be assembled first though. This requires a bit of patience, skill and time. It wasn't too difficult though and took me around two hours to set up. Aside from that, the Cetus has a pretty good printing volume of 18x17x18cm and can even be extended to print larger objects. It's just a nice and reliable little machine that is perfect for some quick prototyping.

NOTE

Need help on finding your dream 3D printer? I actually made a YouTube video where I talk about different machines, materials and qualities. I hope this will be a good guide on how to find a printer that fits your own needs:

https://youtu.be/uT0nw_4p6mc

NOTE

Every printer has its own requirements and works a little bit differently. So make sure to study the user manual to set up your machine properly. I know it's super boring, but many beginner mistakes can easily be avoided if you actually just read the manual!

Resin printers

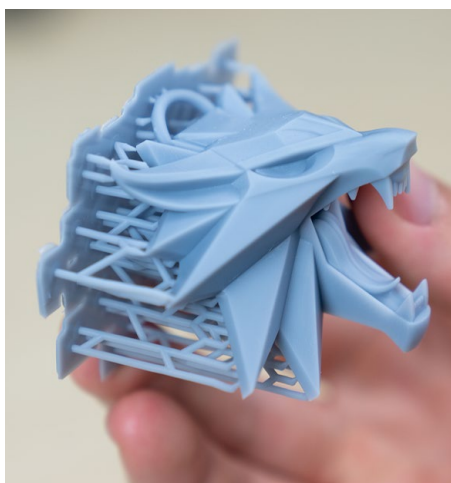
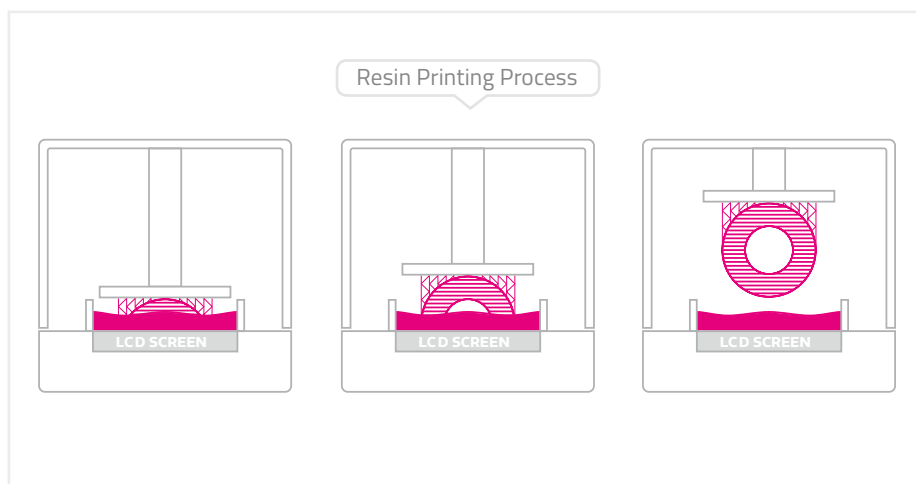
These printers work a bit differently from the FDM machines because they don't "build up" a model layer after layer on a building plate, but rather "pull" the model out of a tank of fluid resin. The general principle goes like this: At the bottom is a LCD screen that uses UV light. The 3D model is split into thin slices that are displayed as a black and white image on the screen. The UV light cures the resin, the building plate moves up a little bit and it's time for the next layer to get exposed. This way, layer after layer the model gets "pulled" out of the resin tank. The nice thing with this technique is that it doesn't matter how much you put on each layer. So no matter if you print one model or 5, it will take the same time as long as they all fit on the building plate. In addition, resin printers have fewer mechanical parts so they are less likely to mess up your print.

The biggest advantage of resin printers though, is the amazing printing resolution and the level of detail. The layer thickness created by the built-in LCD screen is a lot finer than the very limited resolution of a FDM printer. This means that resin printers are especially amazing for smaller accessories and costume pieces. And the best part: Resin printers and FDM printers actually cost around the same these days.

So why not use a resin printer for everything then? Well first, they are annoying to clean. After each finished print, I have to spend around 15 minutes cleaning the resin tank and the building plate. In addition I have to rinse my finished prints in alcohol and then cure them in UV light (for another 60min). It's not a very complicated process but still annoying. Second, resin is also heavier and more brittle than PLA or ABS. This doesn't really matter if you mainly print small accessories but for full armor parts I wouldn't recommend it. Larger costume pieces won't withstand much force and are more likely to break. Finally, the printing material is also a bit more expensive (around \$30-\$50 per 500ml) but at least you can pour all leftover resin back into the bottle again and use it for your next print.

The one I bought

I bought an Elegoo Mars in 2019. The build volume here is only 12x7x15cm but the resolution goes up to 0.05mm/layer. So it has a smaller building plate but a higher resolution than my Zortrax. This makes it perfect especially for smaller and more detailed models. I wouldn't print a full sized helmet on this machine, but any jewelry or smaller parts are awesome for it. In addition, the printer is also able to work with translucent or flexible resins, which allows me to make pretty gemstones or other parts that I can use for my LED projects.





Safety first

No matter what machine you end up getting, seeing how your digital model becomes a real thing that you can actually touch is always exciting. 3D printers are still just mechanical tools though, so be mindful and keep some basic safety precautions in mind:

First, I know there are some horror stories floating around the Internet of people buying really cheap no name printers from dubious sources that ended up starting fires in their homes. So the first tip I would like to give you is when choosing a printer, settle for one that has a large online community and plenty of trustworthy user reviews. It's the easiest way to avoid making such a mistake.

Second, heating up plastic, no matter if PLA or ABS, releases toxic fumes that can be harmful to your health. It's not completely clear how bad these fumes are, but it's always better to be safe than sorry. This means, don't set up your printer right next to your desk. Instead, search for a well ventilated place as far away from you as possible. Open your windows when your machines are working (be careful not to let the temperature drop too low though) and avoid touching moving parts when it's in operation, especially with open printers that don't have an enclosure. Also keep in mind that the print nozzle is quite hot during a

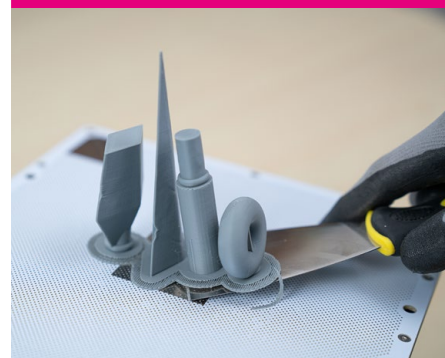
print, and will take some time to cool down after it is finished.

The biggest potential "danger" might come from resin printers though. Liquid resin is highly toxic (just like any other resin for mold making and casting) and can be absorbed by your skin and go into your blood circulation. If you expose the print to UV light, which is required to cure the printed resin, the toxic effects are significantly reduced. So washing and curing your resin prints is a must and sealing them with paint is also a good idea. Furthermore, it's important to avoid any direct contact with the liquid resin. Wear gloves, long sleeves, a respirator and glasses any time you work with it, and instantly wash away drips of resin with cold water. Hot water would actually just open your pores and allow your body to absorb the goo. Allergic reactions are also possible, so make sure in advance that it's safe for you to work with these chemicals.

As a cosplayer or prop maker, this is surely not the first time you have worked with potentially harmful materials. However, I still want you to be as safe as possible, so please put the printer away from you, always wear safety equipment and keep an eye on your printer even while it is working in the background.

NOTE

Personally, all injuries I have ever got from working with 3D prints happened when I tried to remove a finished print from the building plate with a scraper. This often requires quite some force. When your print finally plops off, chances are your hand is next thing in the way of your scraper. Now, I always use gloves and try to be really careful here.



How to get cool 3D models

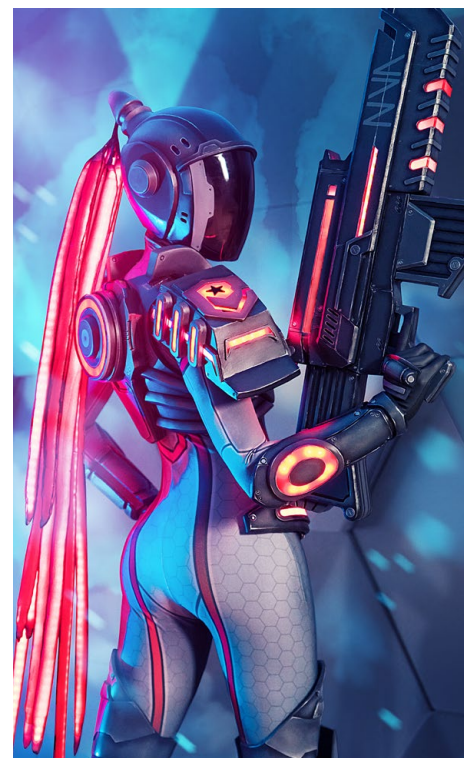
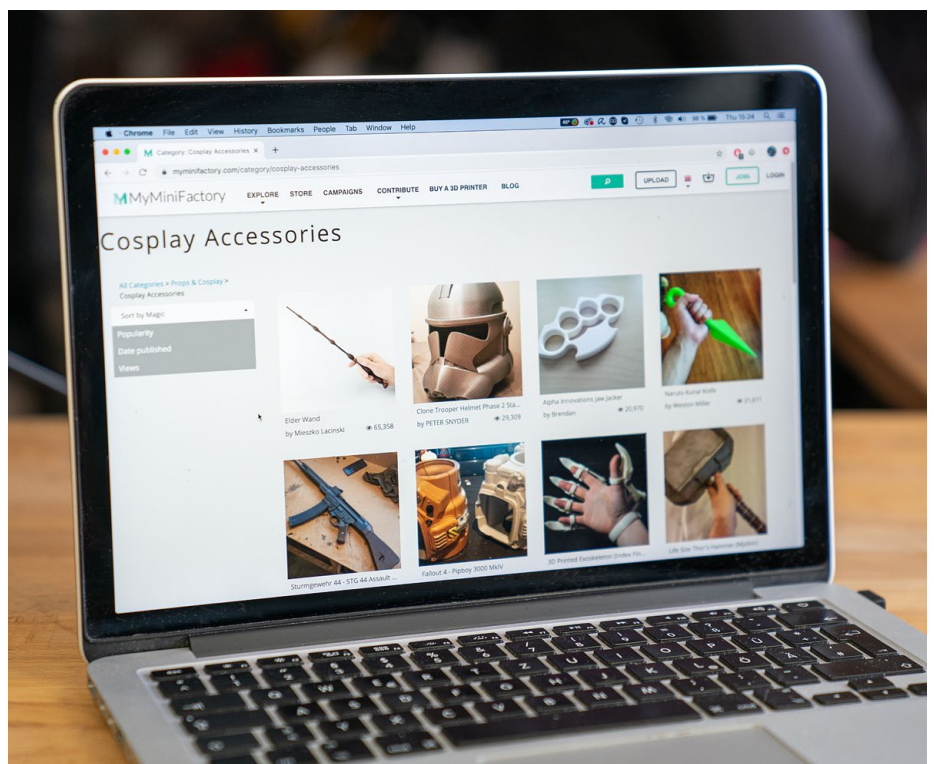
To benefit from 3D printing, you don't need to learn how to 3D model yourself. There are a lot of websites where you can download thousands of miniatures, costume pieces, props and even everyday household items either for free or for a fee. Popular items are usually the easiest to find. There are also plenty of amazing 3D artists who would be willing to help you out in creating models if you have the money to commission them.

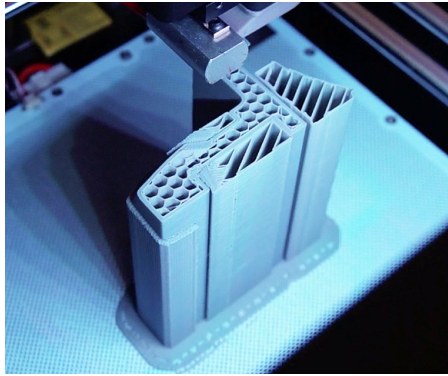
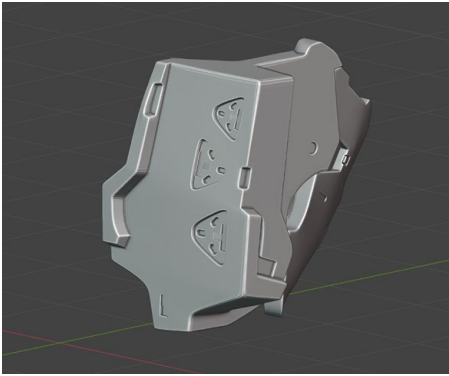
There is nothing wrong with downloading a model, but you first have to be lucky enough to find exactly what you need. Google is your best friend here. A better alternative would be to create the 3D file you want by yourself. I know this might sound intimidating at first, but I promise you, learning this is not as hard as it sounds. In fact it might be the most useful skill you'll ever learn! So, let me introduce you to the wonderful world of 3D modeling!

There are a lot of different 3D modeling software out there and each of them works a little bit differently. If you're like me however, you mainly want something that you can build simple props with, sculpt some textures, and one that also doesn't cost you an arm and a leg. I already looked at most of them and based on my own experience, there are really only two programs you should consider spending your time with: Fusion 360 and Blender.

Of course, there are other useful programs out there, but Fusion 360 and Blender are both very beginner friendly and are free to use. In addition, they have huge communities that can answer your questions, constantly create amazing tutorials and are in general very inspiring and supportive. This is just perfect if you are a cosplayer and want to get started. Other programs like Maya or zBrush might play a bigger role in the 3D modeling industry, but they cost a monthly fee and aren't nearly as beginner friendly.

And before we get started, let me tell you that I myself only got into 3D modeling a few projects ago. Before that, I only ever worked with models I found on the Internet or had someone else help me with them. For example, this helmet from my Nova costume was modeled by my brother (who I paid of course). I didn't dare to tackle such a project by myself since it looked way too complicated at the time. But then I decided to pull myself together, watch some tutorials and finally learn some modeling. With only a few days of training and practice, I was able to create something really cool. Nowadays I just make all my models by myself (see images next page). As with all new techniques in cosplay, the most important part is to make the first step.





"3D printing is cheating!"

Since it's still a relatively new, 3D printing is sadly not as common in the cosplay community as traditional techniques like sewing or wig styling. You often might encounter the prejudice that it's "cheating" and not real crafting since "you only press a button and your costume is done". People often don't understand the time and effort that goes into 3D printing and might not appreciate the hard work. They might even criticize other people for using a 3D printer and say that they prefer "real craftsmanship". I encountered plenty of these comments myself. The fact is however, that 3D modeling and printing is just another technique similar to sewing, leather working or foam smithing. A 3D printer simply gives you new possibilities to turn a specific material into a costume piece, so there is nothing wrong with using this tool just like any other. It's also not like you press the button of a sewing or embroidery machine and your costume is done, right?

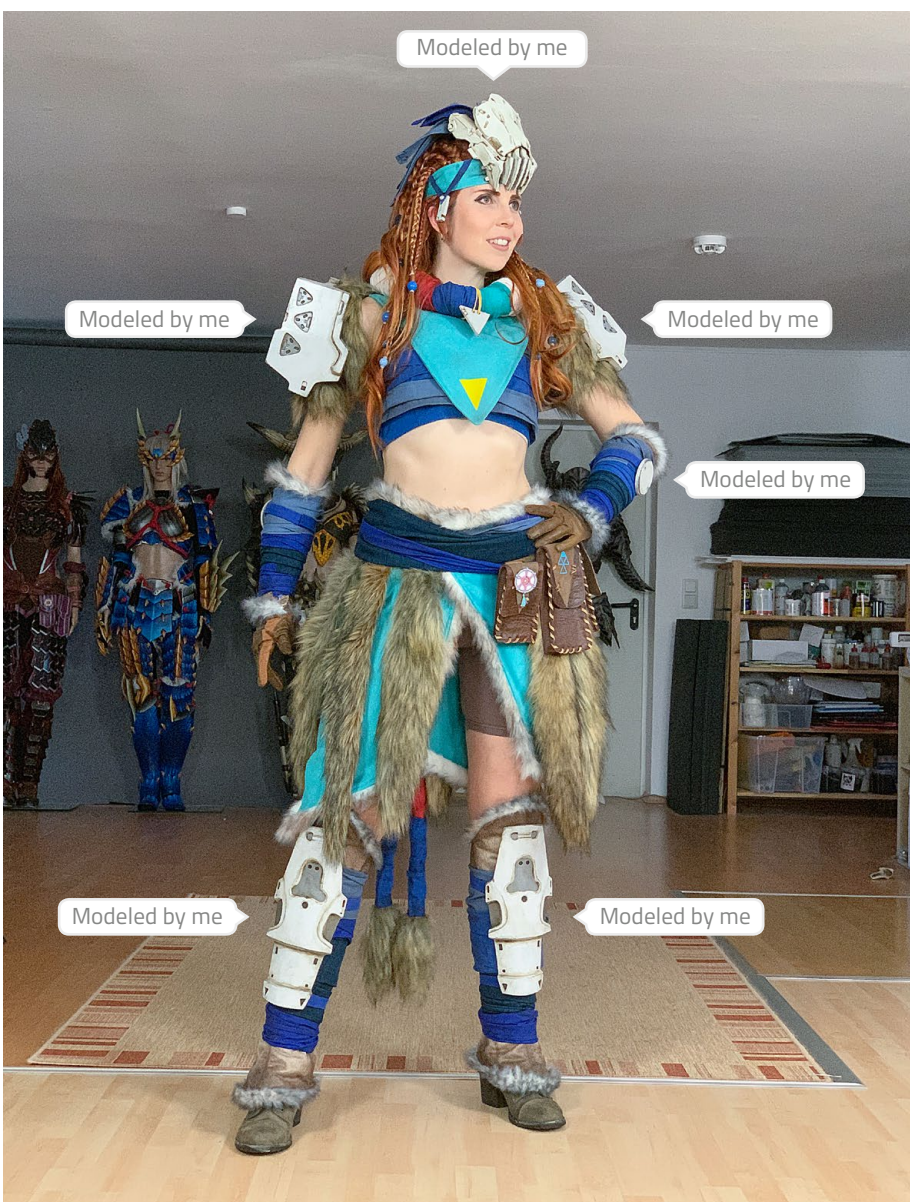
Anyway, don't worry about what others say. Most of them have never worked with 3D printing themselves and simply cannot imagine how much work goes into learning the necessary skills needed, from creating a 3D model to finishing a printed piece. If you are creating the 3D file yourself, the necessary time and effort might be even more than if you were to use foam or Worbla. 3D printing is surely not a shortcut, but is actually more of an opportunity to create something exactly the way you want it - just what you need if you are obsessed with accuracy!

It took me days to sculpt all the different armor parts of my latest Horizon costume **[images to the left]** and even many more days to print, sand and finish them all. I had a ton of fun doing it and learned a lot that will help me finish my next projects even quicker. I am really proud of it, and that's all that matters.

In addition, there is absolutely nothing wrong with just downloading a 3D file and finishing it. Just be open about your process and give the original creator of the 3D file credit for their work. This way you are not only able to support an artist who had helped you finish your project, but also shows that 3D printing is something that everyone can use! Cosplay is about having fun and helping each other.

NOTE

Most 3D files you can download are in .stl or .obj file format. They can be opened and edited without restrictions and with any common 3D software.



Autodesk Fusion 360

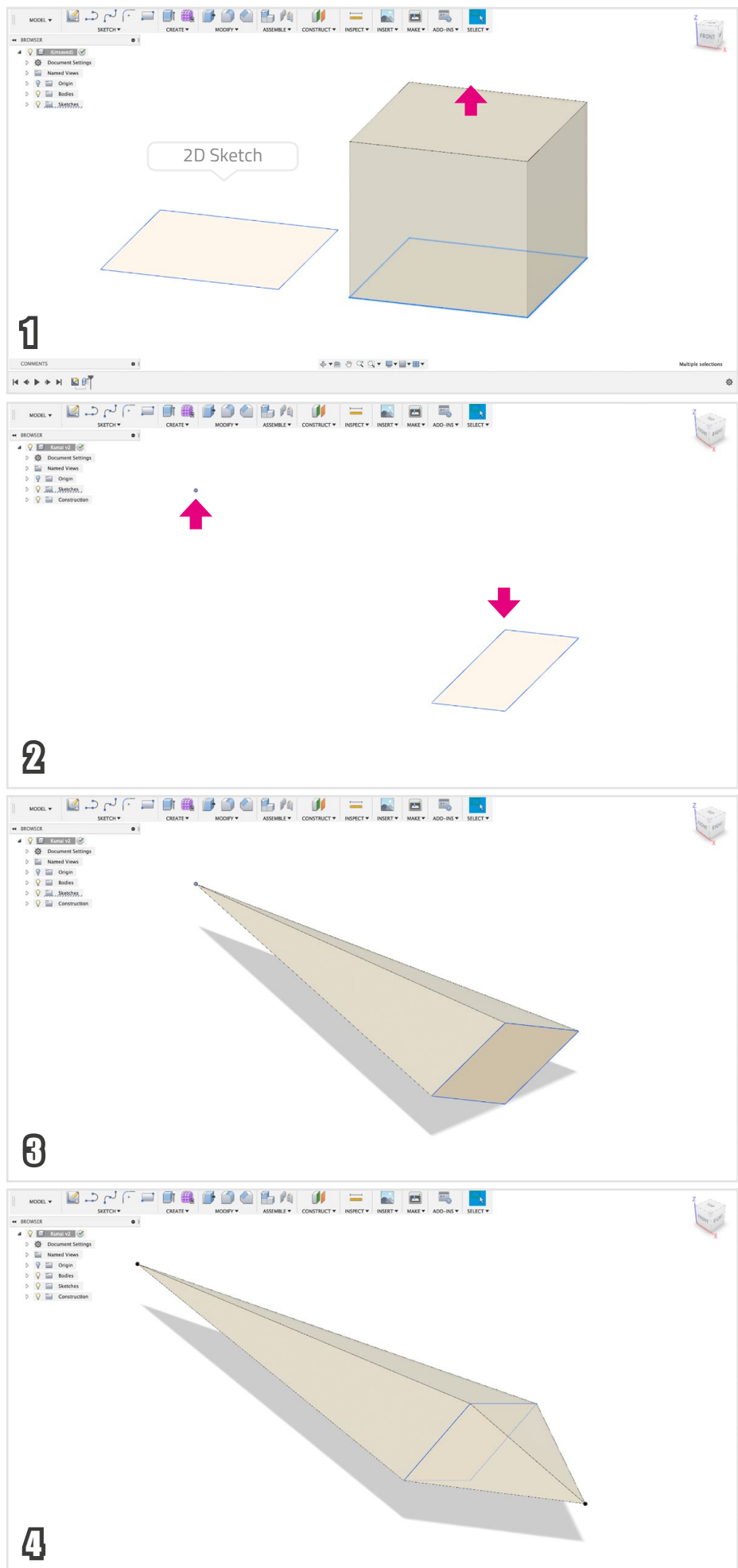
Fusion 360 is free to use for hobbyists and start-ups. It's a CAD program (computer aided-design) that allows you to turn a two dimensional blue-print into a ready-to-print 3D model. The way it works is you basically first draw a simple shape (also called sketch) like a square, and then extend it upwards until you get a three dimensional cube^[1]. Then, you are able to rotate, cut, rescale and reshape this cube and even add more elements on top. It's probably the easiest way to get into 3D modeling for anyone who has ever drawn a blueprint for a prop before.

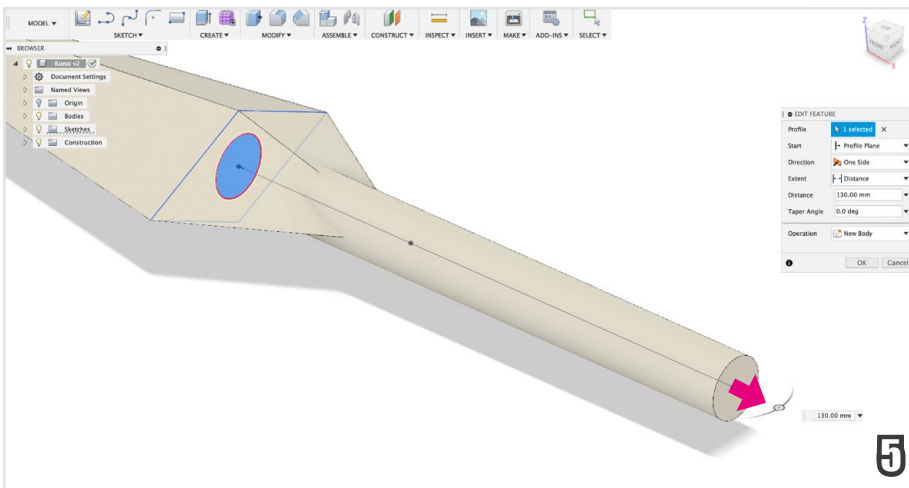
Once you open the program, you'll find an empty stage with a grid and real-life measurements. All the tools to draw sketches as well as creating the 3D shapes are on the top bar. In the top right you'll find the camera control to set up your view. At the bottom is your history, which allows you to undo and to correct previous steps. On the left there is a list of all the objects you've created. That's pretty much all you need to get started.

Now, Fusion works a little bit differently than other 3D programs. Yes, you can click on a button and a cube or a sphere appears which you can edit afterwards. However, you can also draw a square on the ground and tell the program to extrude it upwards, so it becomes a cube. If you draw a circle and pull it upwards, you can create a cylinder. A pyramid is a square on the ground, whose four corners are connected to a 5th point hovering above it. You get the idea. This functionality makes the program incredibly valuable when it comes to building a 3D model based on flat drawings. As a beginner you also don't need to start at zero and have to figure out how to edit a cube first. Instead you can use a 2D drawing as your base and then build a ton of cool stuff with only a small number of really simple tools.

For my example I'm going to create a quick kunai, which you will recognize if you know what "Naruto" is (believe it!). It consists of relatively simple shapes, so I thought it would be a good example to explain Fusion 360 in a little bit more detail.

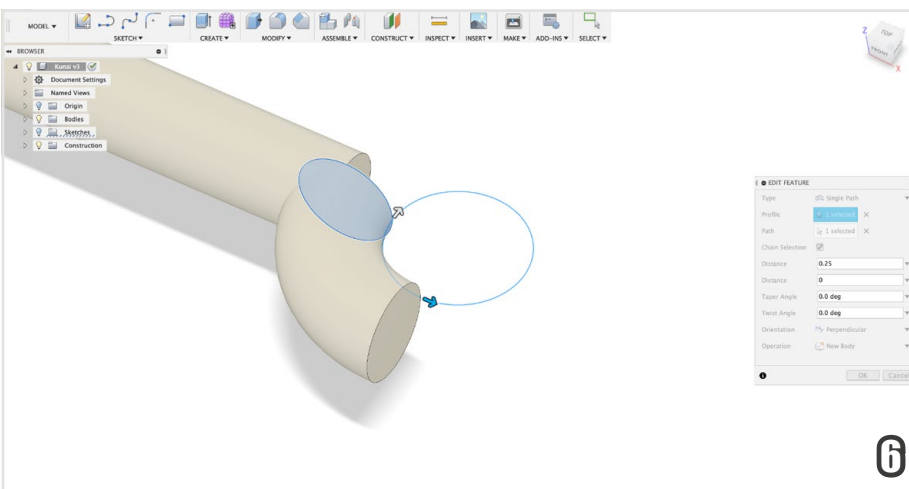
To get started, I drew a slightly squashed square. I also created a single point at what would become the pointy tip of the blade^[2]. Now I selected both the pointy tip as well as the point and told Fusion to connect the two. This resulted in the shape you see in picture ^[3]. I also did the same for the other side but shorter. Hey, the blade was already done^[4]!





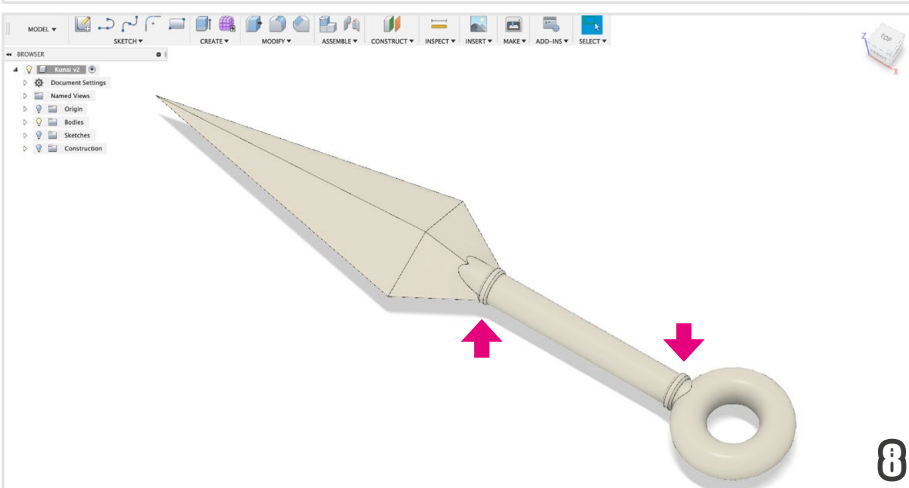
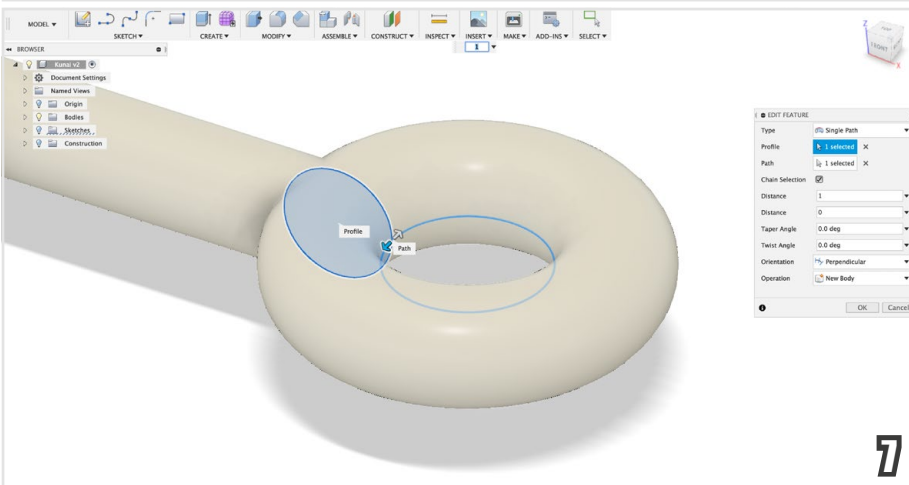
For the round grip, I placed an additional circle to the center of my rectangle and extruded it outwards away from the rest of the blade [5]. I measured my hand with a ruler and made this part as long as I needed it to be to fit into my palm. Then, to finish this prop, I needed a donut shape at the end. To create this, I drew two more circles. One for the diameter of the donut and one for the size of the donut hole. Now I told Fusion to rotate the diameter circle along the donut hole and ta-dah, the end was done as well [6-7]!

At this point my kunai was basically done, so I simply added two more smaller rings around the grip for details and decided that I was done [8].



As you see, Fusion 360 allows you to work with very basic shapes and tools. Just by using a few drawings you can create something awesome. It's a great program to get started with 3D modeling and it teaches you how to construct something complicated out of very plain, geometric shapes. This was of course just a very simplified explanation of how the program works, but I hope you get the idea. If you want to see me build a full Fallout prop and explain every step of the way, just watch this video I recorded a while ago.

My video about working with Fusion 360:
<https://youtu.be/ZSaJ6AHcD-g>



NOTE

The best way to get started with Fusion 360 is to find something very simple with an easy sketch as a base. Just pick a button or a brooch for example. Finishing a small piece like this will already help your confidence grow!

A short intro to Blender

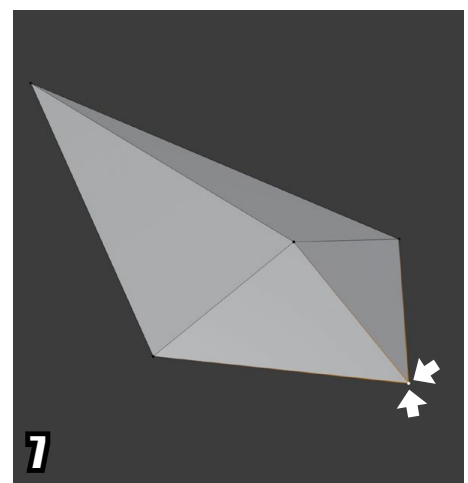
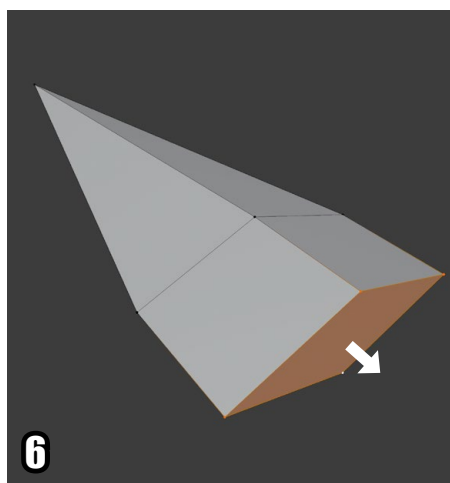
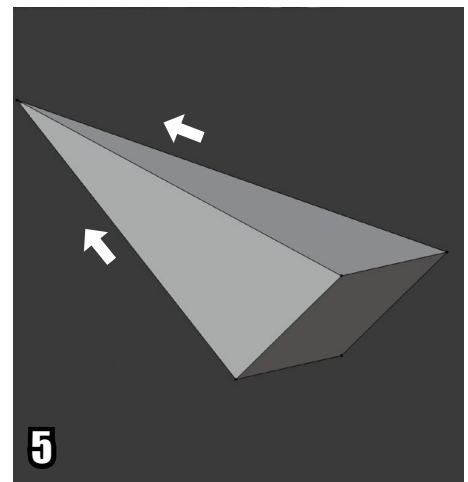
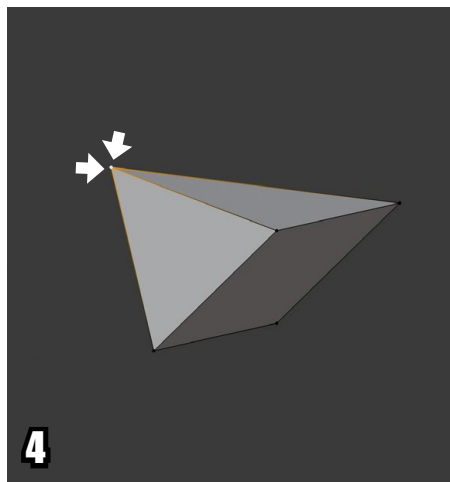
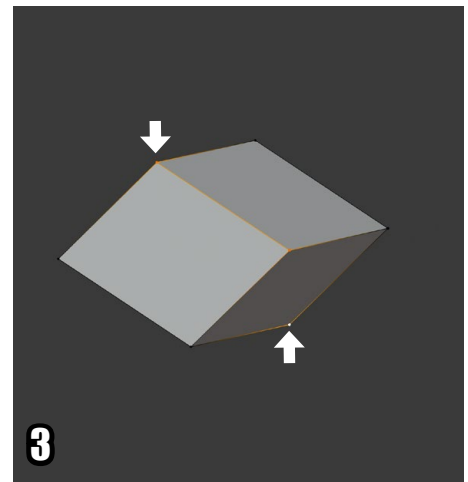
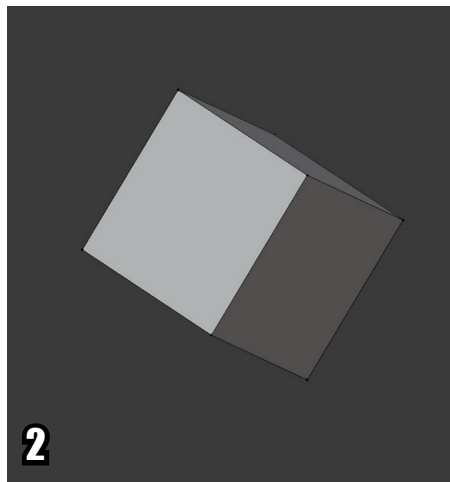
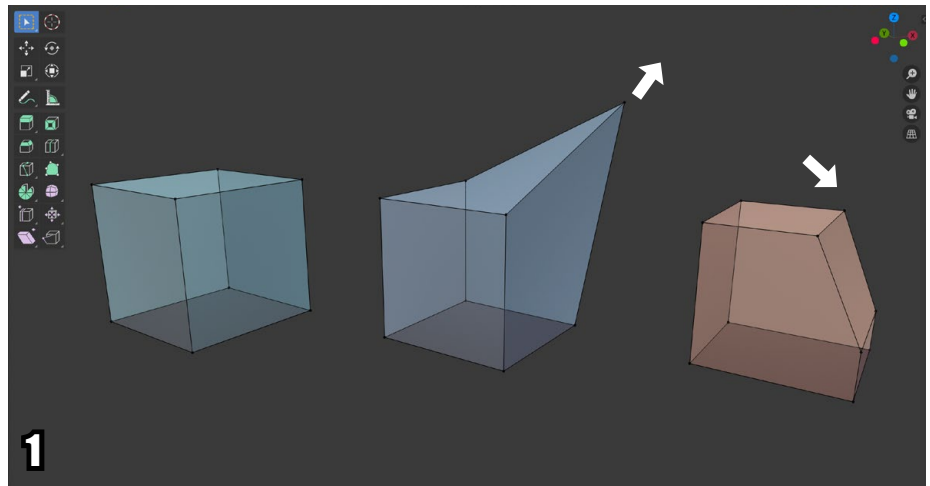
Blender is a completely free, open source 3D modeling and sculpting software with a huge constantly growing community behind it. This means the program is super beginner friendly compared to other 3D modeling software like Maya and zBrush, and it's incredibly easy to get started. The community provides all kinds of tutorials for pretty much everything you have in mind. They constantly improve the software's functions and user interface, and are always there to give you a helping hand. Pretty similar to the cosplay community actually, and I think that's awesome!

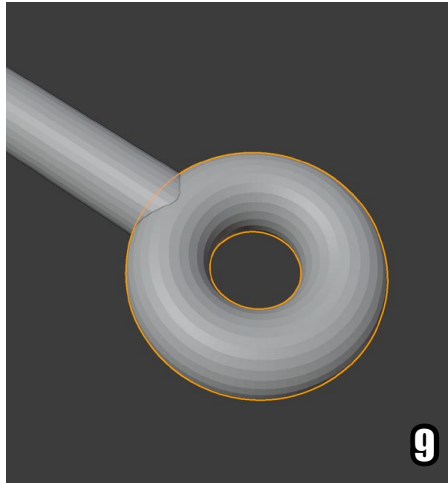
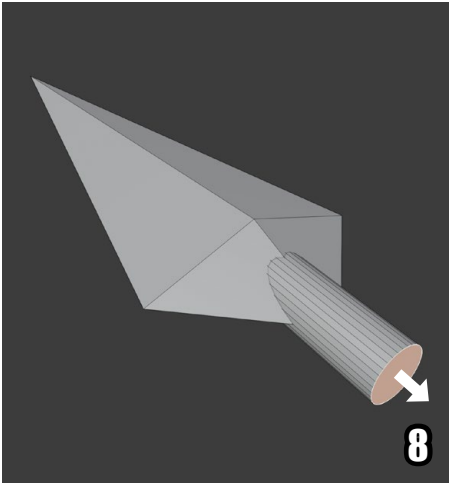
So, to get started, all you need to do is download the software from blender.org, install it and just open the program. I highly recommend watching one of those "getting started with Blender tutorials" on YouTube to get an overall idea of the program. You'll find most tools on the left and right sides of the interface. Blender works a little bit different than Fusion though. Instead of drawing a sketch first, you simply ask Blender to create a standard geometric object for you. This can be a sphere, a cylinder or a cube. Now you are able to move and warp every point, line or surface of this shape. Simply grab a point and stretch it to one side or use a knife to cut it apart like butter **[1]**.

So, to create the same kunai as before, I started with a basic cube **[2]**. As you can see, I rotated it sideways by 45° and then selected the top and bottom line to squeeze it together **[3]**. Then I selected all four points on the left side and told them with the right click menu to merge together at the center **[4]**. Bam! Pyramid! Now I just dragged this new point a little bit further out and got the pointy end of the kunai **[5]**.

For the shorter end I marked the bottom of the pyramid and extruded it to the right forming an additional cube **[6]**. Then I merged the center of it again to get the other end of the blade **[7]**.

As you can see, reaching this point in the process took me a few more steps than in Fusion 360. I also have more control of my shapes since at any time, I can simply select a point and move it around without having to change any sketches.

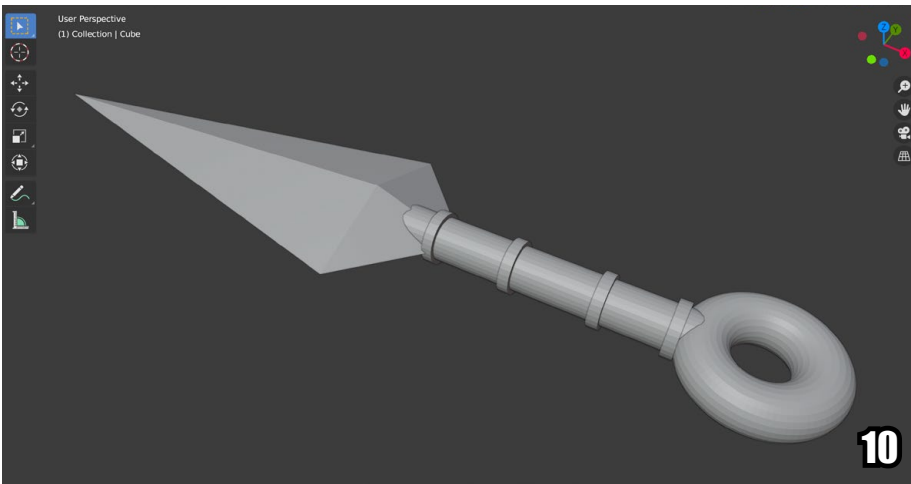




Next I added a cylinder, rotated it to the right position and extruded it out long enough for my grip [8]. The donut at the end was also just a standard blender torus that I moved all the way to the right [9]. I only added a few more decorative rings around the handle and the base of my Blender kunai was done as well [10]! Neato!

If you want to see a more in-depth tutorial on how to get started with Blender, I also made a video for that!

My video about starting with Blender:
<https://youtu.be/vvuah9D9NJw>

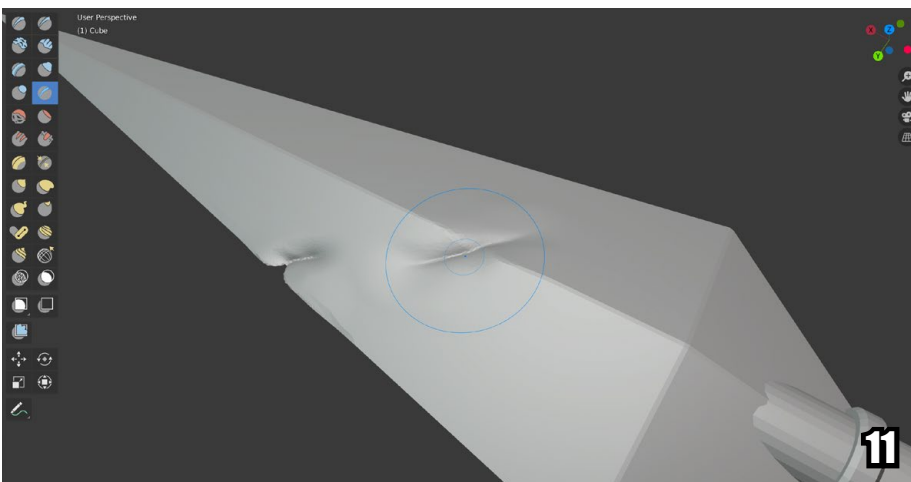


One cool feature that Blender offers but Fusion doesn't, is the option for organic sculpting. This allows you to work on your 3D model like it was made out of clay. Blender offers different sculpting tools similar to silicone brushes, texture sponges or scrapers. I used a few different tools to create some battle damage around the blade, to roughen up the surface and make it look old and worn. This gave my whole 3D model a more believable look [11-12].

While Blender and Fusion 360 both are awesome, they also have different uses. Fusion is great to get into 3D modeling and to understand how these kinds of programs work. It gives you a good starting point if you have already worked with blueprints and is especially handy for props and costume pieces that need very exact measurements. However creating something more organic looking or objects that are not based on simple geometry, can be a hassle. Great for massive crazy space guns, bad for sculpting small organic looking wooden sticks.

Blender on the other hand, is a little less beginner friendly, simply because it has a lot more functions and applications. However, it also gives you more creative freedom and even allows you to produce assets for movies and video games. You just need to spend a bit more time watching tutorials online.

Which program you prefer is totally up to you of course. I personally use both usually for different applications, but I also often even combine them. Sometimes I just model something super fast and easy in Fusion 360 and then simply import the 3D model in Blender and add further details and textures. The most important point is to not be afraid of starting. I promise you, learning 3D modeling is not as difficult as it looks. Plus, if you understand one program, it's super easy to learn the next one.



Preparing your prints with a slicer

If you want to turn your 3D model into a real life object you first have to convert it into instructions that your printer can understand. This process is done with a “slicing” software. It quite literally “slices” your 3D models into very thin layers and then tells your printer the exact movement and amount of filament it needs to build up your model in real life.

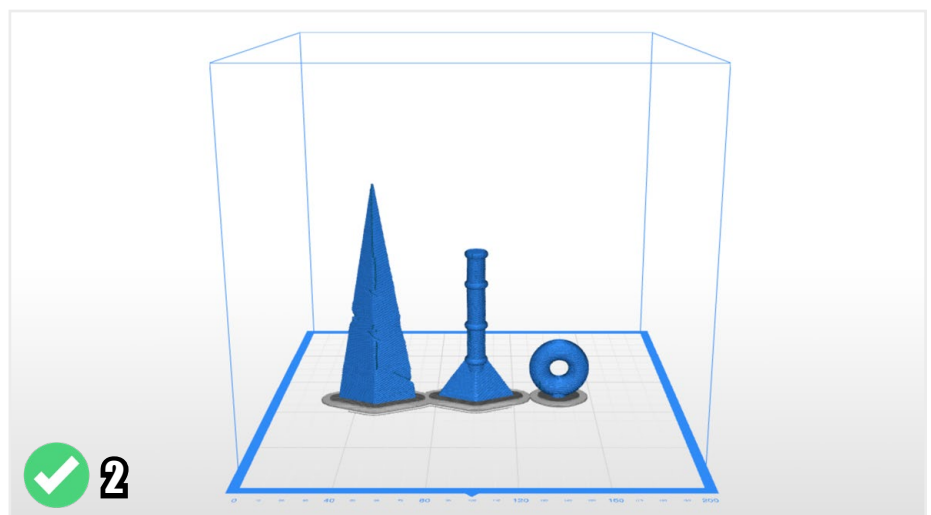
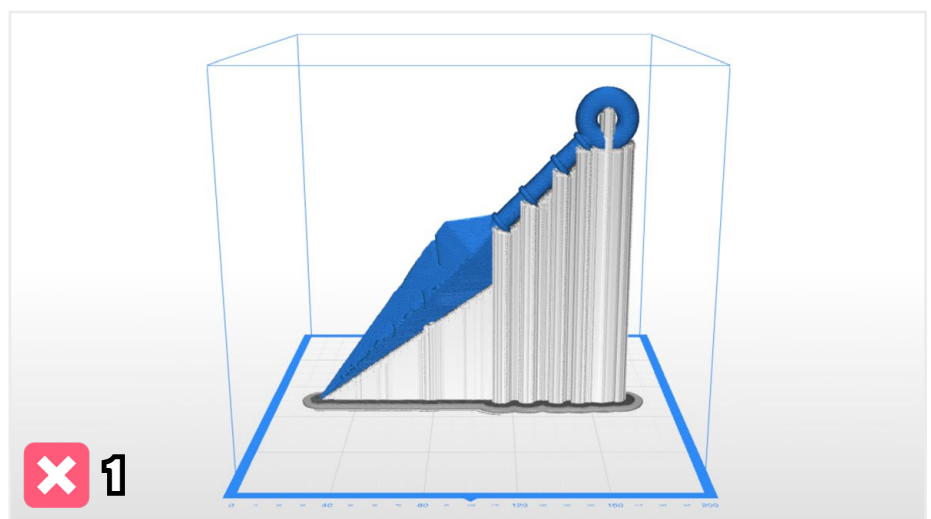
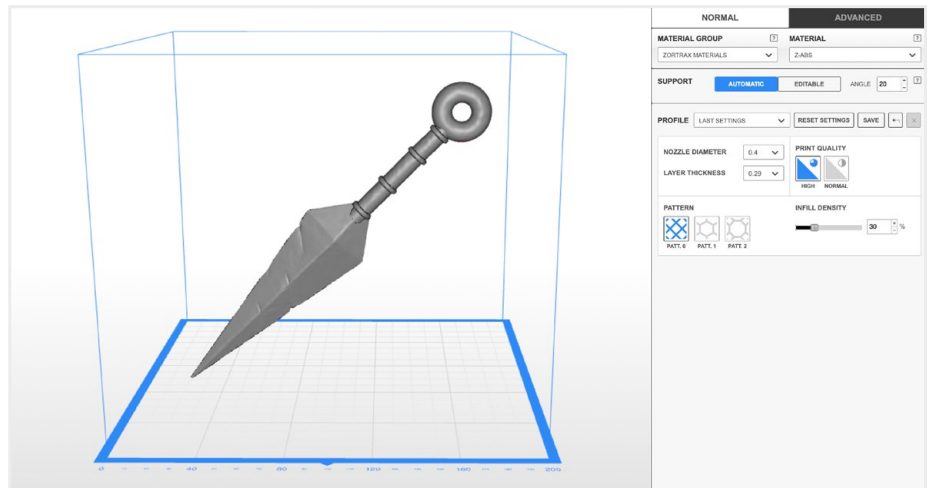
A good slicing program includes plenty of options to move, rotate, rescale and even split your model into multiple parts for printing. Here you also set the resolution, printing speed, support material and infill (more on that soon) - all of which will influence the quality, stability and weight of your print.

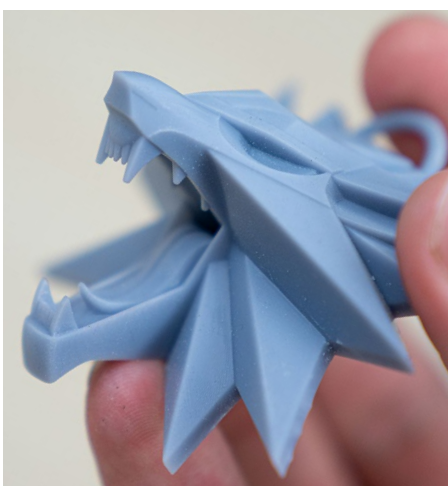
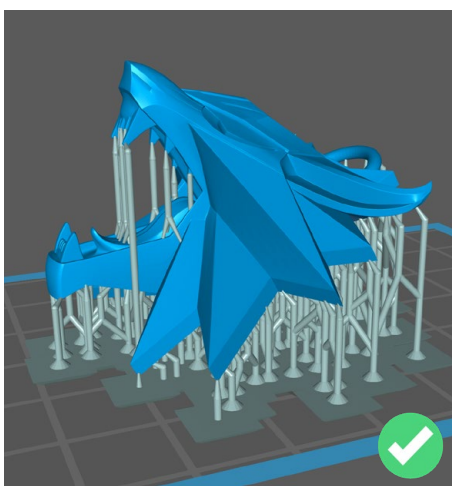
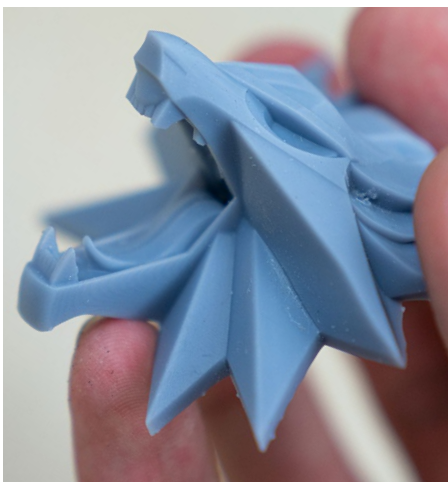
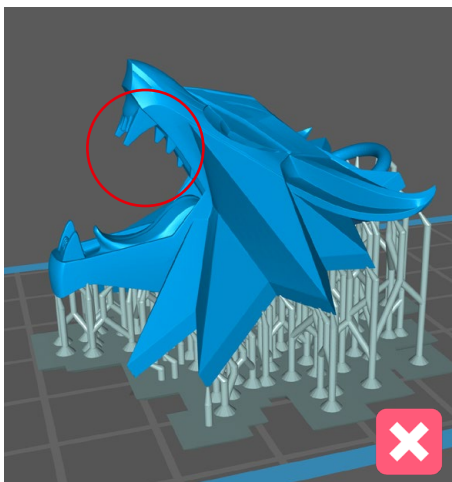
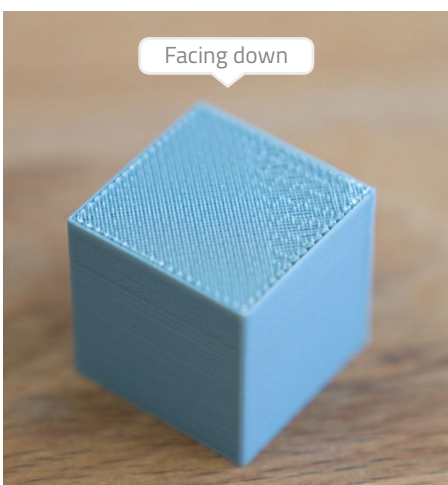
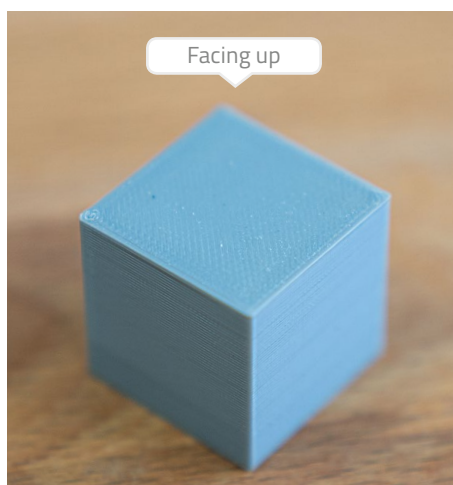
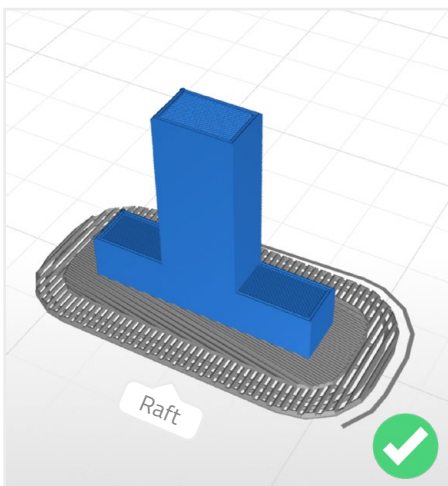
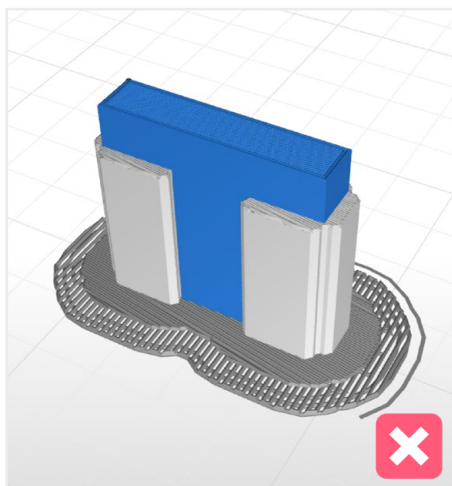
Sadly you can't just click “print” and the 3D printer figures out the best settings for you, then does some magic, and an awesome new costume piece is done overnight. While some slicers do offer a robust “auto place” function, they are not 100% reliable so I still recommend learning a thing or two about good model placement and rotation. These setups are not only important for a clean print with a minimum amount of material, but also determine how light or heavy your printed piece will be. And believe me, you don't want to wear 20kg of plastic all day on your body on the convention floor!

Many 3D printers actually come with their own slicing software (like our Zortrax) or at least recommend a specific program to use - but there are a few slicers I can recommend: Ultimaker Cura and Raise3D Ideamaker for FDM machines and ChituBox for resin printers. All of them are free to use and work very similarly. Explaining a single program in detail would not be of much use for this book though, so instead I will show you the most basic settings they all share.

Let's start by trying to print our kunai model from before. There are plenty of ways to place the model. The upper example to the right **[1]** would require a lot more “support material” (next page) and therefore not only cost more and take longer to print, but also result in a pretty rough surface on the side of the blade that touches the support. The downward facing parts of FDM prints generally look a little worse and require more work than the upward facing sides since the support needs to be clipped off and leaves ugly marks.

The lower image shows a better printing solution **[2]**. I split the model into three parts and now only need a minimum of support material, less time to print and will get a much cleaner result. Gluing pieces together is easier than having to fix an entire print.





Scale, rotation, rafts & adding support:

The first thing you have to do after you load your model into your slicer is to set the scale and rotation of your print. Obviously you should scale it to the measurements you want for your piece. Most slicers offer extensive settings to change the size, and usually display the current dimensions prominently. The rotation and placement however can be a bit more tricky. The thing is that traditional 3D printers cannot print in mid-air. They always need something to print on or grab on to (for resin printers). This is why they have to add "support". Support quite literally creates a support structure the machine can then print your model on top of. How you rotate your 3D object now influences how much support you will need to add. If you print a "T" structure upright, you'll see what I mean. The entire arms would need to be supported. Turn it upside down though, and all of the support is gone. Better!

A general rule of thumb is to rotate your model in such a way that it needs the least amount of support. This will make your prints finish a lot faster and also take less printing material. Like I said before though, the surface that faces downwards towards the building plate will look worse than the one facing upwards. Just try to keep those two factors in mind when placing your models.

To make your print stick well to the building plate I also recommend checking the "raft" check box in your slicer. This will create a small platform your model will be printed on top of. It might not *always* be necessary especially when printing with PLA, but I found that using them will lead to better results.

Placing your models, rotating them to a good angle and adding support also works similarly for resin printers, even though your model is not "built upwards" but rather "pulled out". Resin print slicers are a little bit faulty here and there though and can easily mess up your print if you don't keep your eyes open. My slicer didn't automatically add support to the teeth of my Witcher medallion for example. This resulted in a wolf without any teeth. Poor doggo! So, I manually added support as you can see in the lower image.

Every part of your model needs something to hang onto, so you will need to add enough support where it is needed. Sometimes the slicer just needs a little bit of extra help from you. In addition, rafts also help your model to stick to the building plate which is especially useful for larger and heavier models. All of this might sound quite theoretical, so just print a few pieces yourself and learn from both your good and bad experiences.

Material, resolution & infill:

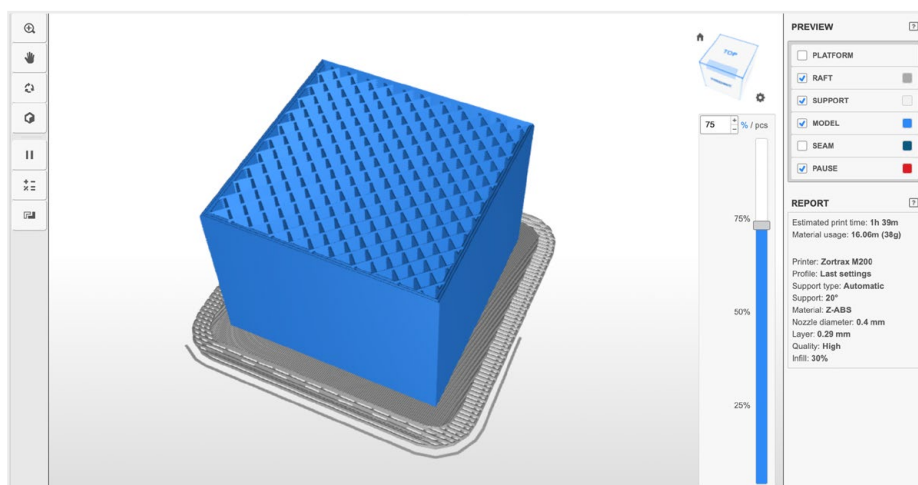
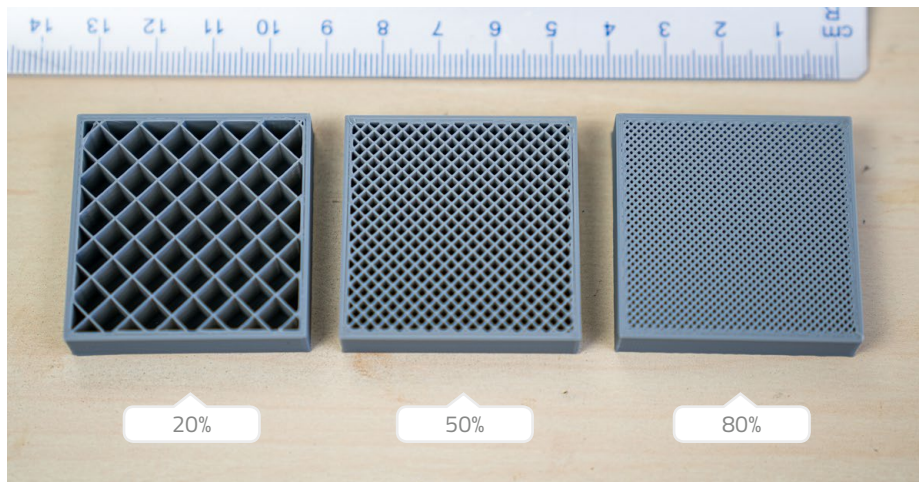
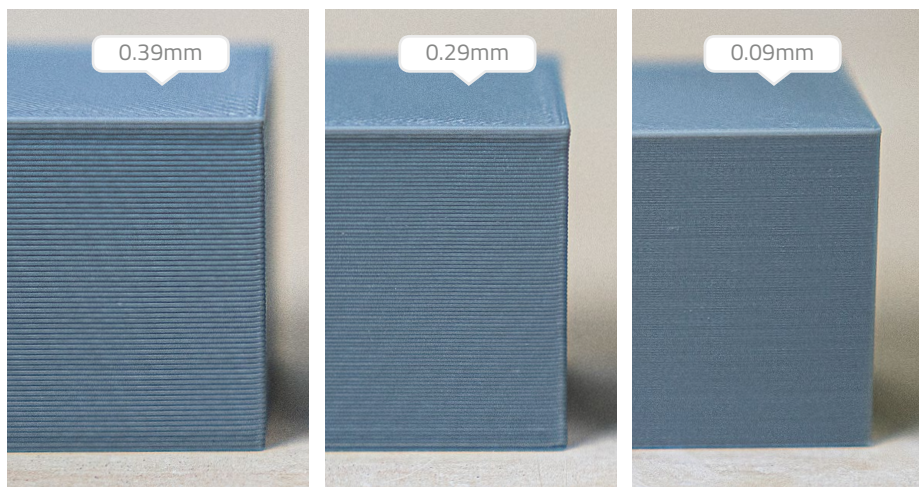
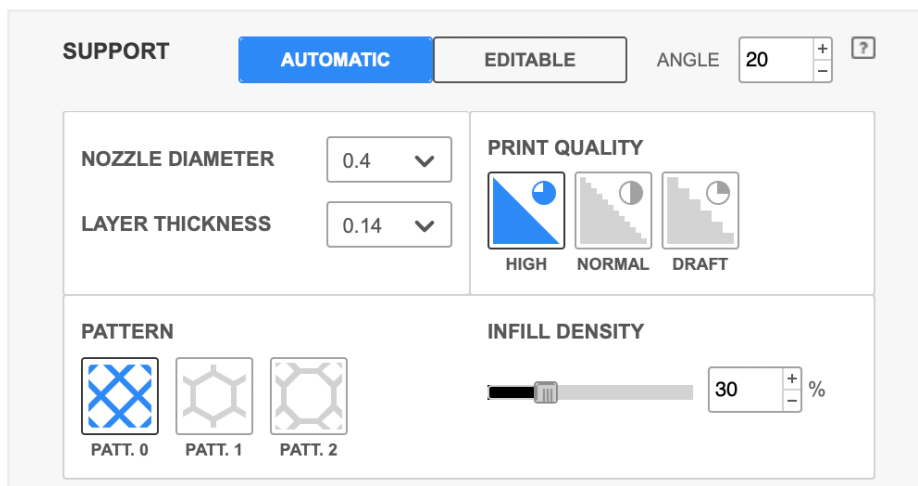
After you've chosen your scale and position, you also need to select your printing material (like PLA or ABS), printing resolution, and infill density. For FDM machines, a larger layer thickness (like 0.29mm or 0.39mm) requires a far shorter printing time which can be great for last minute projects (like at 2am before the con), and also large costume pieces or test prints. The layer lines will be more visible though and might require more time and effort for a smoother finish (more on the following pages). Thinner printing layers however (like 0.14mm or 0.09mm) can take an eternity to print, but the result will be smoother and details prettier. Usually, I go with the higher resolution anyway, since I hate sanding and the costume won't be done until the con anyway, lol. I'll just go naked, who cares?! It's a thing in Germany, really! Just Google for FKK (oh wait, please don't!)

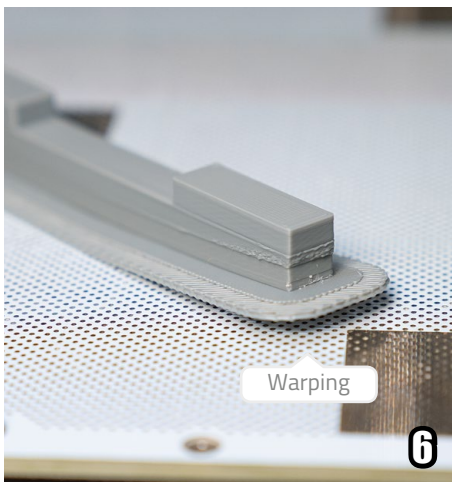
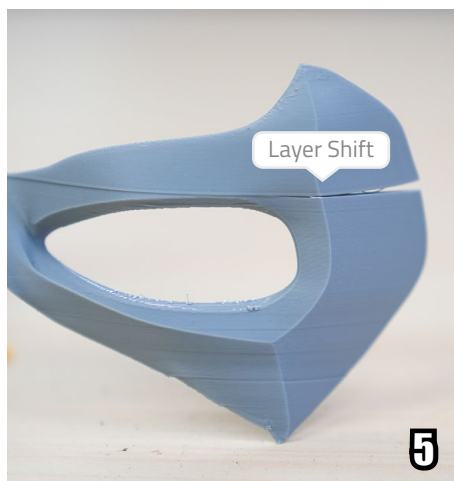
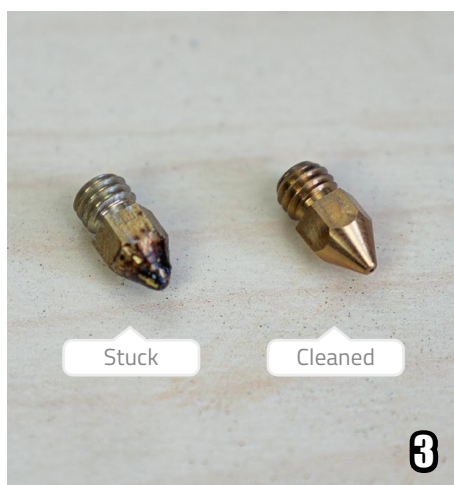
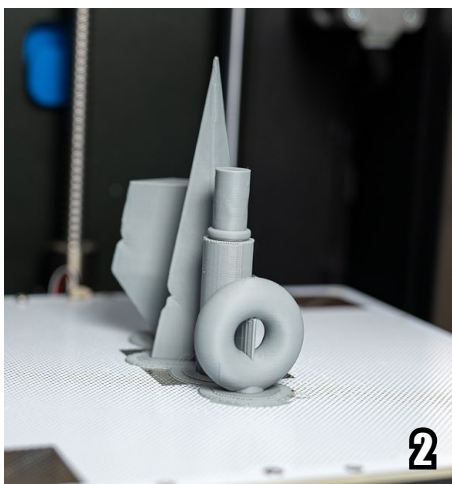
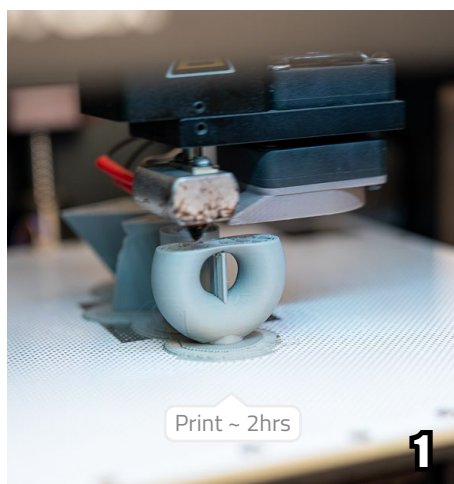
The available layer thicknesses actually depends on the nozzle size. Most printers come with a standard 0.4mm nozzle, so make sure to select the same one in your slicer as the one that is actually screwed onto your 3D printer. I've never used anything besides a 0.4 nozzle anyways.

Next is infill. Some programs let you choose a percentage and even a specific pattern here. It lets you basically print something hollow, with a medium infill or completely solid. This mainly affects how lightweight your piece will end up, how long the print takes, how much force it can withstand, and how much material you end up using. Don't try to print your prop last minute completely hollow with your final spool of filament 2 am before the con though, the poor thing will be as fragile as my ego when you tell me I love cake just a bit too much. 3D prints can become quite heavy though, so I suggest using a lighter infill (like 20% or 10%) for anything you want to carry around all day. Resin printers, on the other hand, typically print everything completely solid unless specifically told otherwise.

I wish there was a magic setting I could just give you that prints everything perfectly, but the reality is that every machine and every slicer needs to be handled somewhat differently and you will mess stuff up in the beginning. Learning how to get the best results out of your 3D printer is part of the fun. Enjoy your achievements just like your failures. It's part of the adventure and racing towards a goal is often far more exciting than waiting all day at the finish line.

Once you've chosen all your settings, you'll get a preview of the upcoming print. Here you will see how long the print will take, how much material it will require and how the support material as well as the print itself will be built up. Once you are satisfied with the result, save it, and send it over to your printer.





Final preparations

Time to hit the start button? Not quite! Here are a few things to check first: Make sure your filament spool still carries enough filament to print. I got used to just writing down the necessary printing material for each project on a sheet of paper and then deduct all numbers from the whole spool. Otherwise, your print might stop halfway. Printers don't actually tell you when they are empty, so take care.

In addition, it's important to level your building plate. This means the nozzle needs to have exactly the same distance to the plate in all 4 of its corners. To release a finished print you often have to take out the plate and put it back into the printer afterwards. This might mess up the position slightly and can lead to problems, so make sure to level it regularly. Some printers do that by the push of a button or ask you to do it manually by adjusting some screws here and there. Just check out the printer's manual to figure out how it works. Resin printers need to be leveled after every print.

What could go wrong?

If you've set up everything correctly and prayed to your lucky star, your 3D printer should now print smoothly for the next couple of hours [1-2]. I recommend checking back a few times during the process to see if everything is still in order. If something was messed up, just try again! The material only costs a few cents so the only thing you lose is time. My most important advice is simply to start early and to calculate some misprints into your project.

Most of the mistakes in FMD printers are simply caused by its mechanical parts. Material in the heating nozzle can get clogged just like your hot glue gun can get clogged. The only solution here is to clean it with an acetone bath or to replace it completely [3-4]. This sucks, but happened a few times with our Zotrax printer. In addition, the mechanical parts and gears can have a little hiccup or skip a gearwheel. This results in shifting printing lines or ugly gaps in the print [5]. In addition, large models that take up a lot of space might cool down faster than they're supposed to, warp a bit, and then plop off the building plate [6]. So try to avoid printing overly large parts and separate them into smaller, more reliable pieces. The craziest thing however is filament spaghetti. This happens when the nozzle gets stuck on the print, knocks it over and just keeps on happily printing in the middle of nothing [7]. This might happen in prints that are too thin or too high, so again, separate them into smaller ones.

I surprisingly haven't had much trouble with resin printers yet. Apart from some missing support material, they have proven to be more reliable.



How to finish rough prints

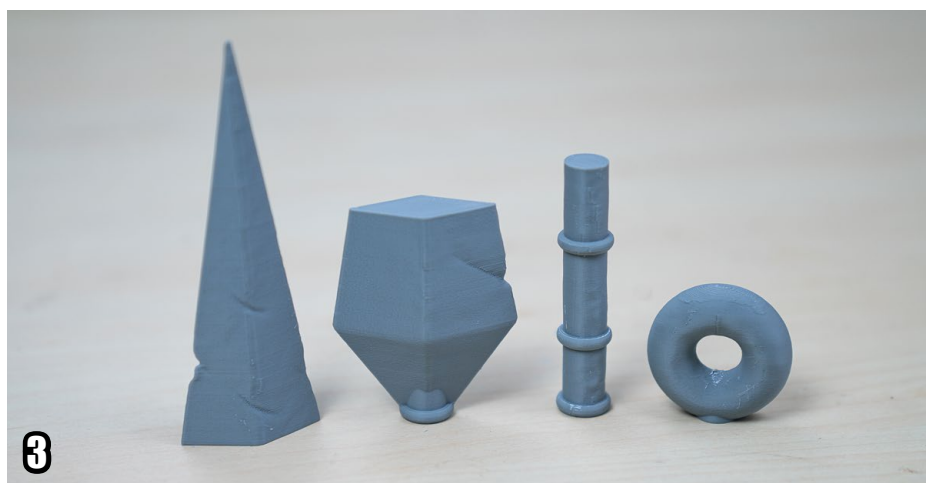
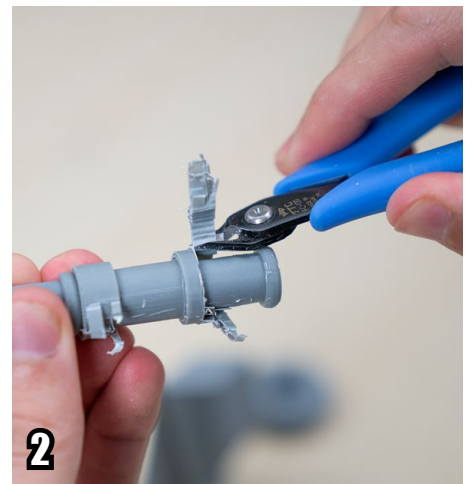
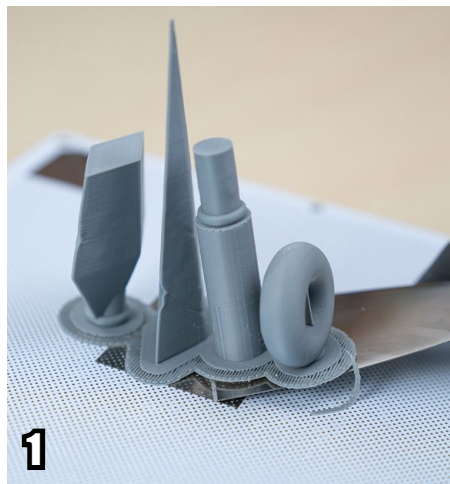
Then, at some point, when you've almost forgotten about it, your printer will make a BEEP sound to tell you it is finished. Finally! Now, the "real fun" begins. Above you can see what a difference a little bit of spray filler and sanding can make. Just give your prints a little bit of extra love and they will turn from a rough print into a beautifully convincing costume piece!

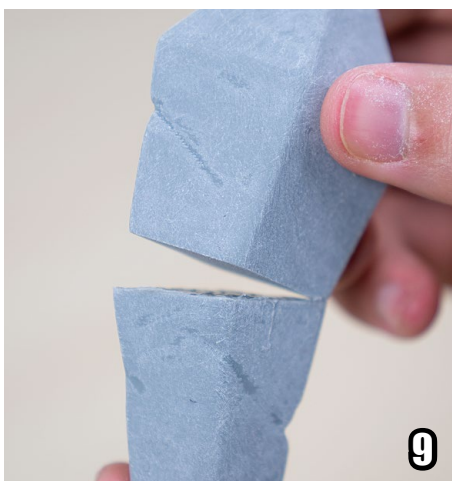
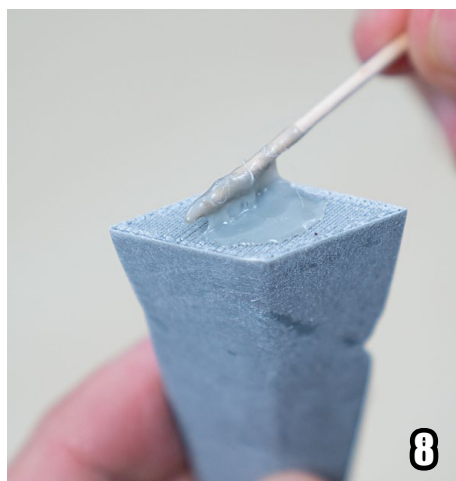
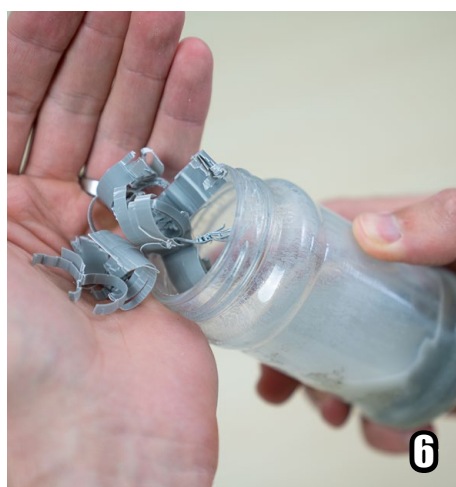
Finishing ABS prints

I already printed my kunai with a resolution of 0.09mm/layer, but there are still little lines everywhere that would drive me crazy if I just painted them now - so let's make it all smooth first!

To start, release the print from the building plate. For this job I used a simple metal scraper **[1]**. Next I put on some safety glasses and used sturdy pliers to remove the support material from my print **[3]**. The support is usually much thinner compared to the model so you shouldn't have trouble here, though especially with PLA some more force might be necessary. Then I mostly went over everything again with a pair of small plier or a precision knife to get rid of any remaining support bumps afterwards.

Depending on how large your 3D print is and in how many sections you've sliced it, you can either start sanding now or glue everything together first and then sand it afterwards. I usually glue the big pieces together first unless sanding them separately makes more sense because of their shape. It's sometimes just really difficult to reach every tiny corner if you glue everything together at the beginning, so think about sanding before you happily smash your print together with glue. For my kunai I sanded the pieces first, then put them together later **[3]**.

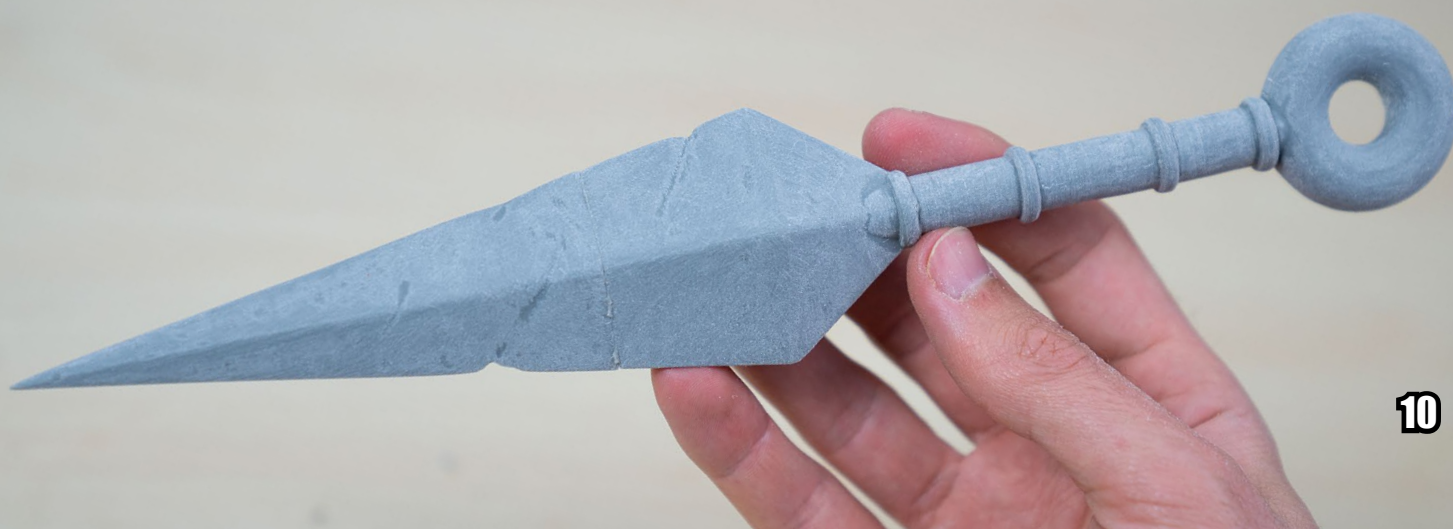




For sanding I grabbed my small triangle mouse sander with 120 grit sanding paper and roughly went over everything first **[4]**. ABS actually sands really well so it shouldn't take too long to get rid of all the major layer lines. Please make sure to wear a proper respirator at all times while sanding your prints. You surely don't want to get plastic dust in your lungs, right? After the first rough pass, I switched to regular sandpaper (120 grit again) and worked on all the little parts the machine couldn't reach by hand **[5]**. When all the layer lines had disappeared it was time to glue the individual parts together.

While PLA and resin prints require a separate glue to stick (more on that later) ABS parts can actually be glued together with a self-made ABS "slush". For that, all you need is a glass jar, your clipped off support material from before and some acetone. Put some acetone in the jar and then add the support leftovers **[6]**. Your acetone and support material should be a little bit like cornflakes and milk. Don't use too much acetone, since you'll end up with soup but also don't use too little, since it will become a lumpy mess. So just be careful here. If you wait for about an hour the ABS will melt and form a thick liquid similar in consistency to honey **[7]**. This ABS slush can now be applied to both sides of your pieces (I do it with a toothpick) and the solution will melt the surface of your prints. Once you stick them together and the remaining acetone of your slush has evaporated, the prints will be connected very strongly **[8-9]**. Just hold them together for around one minute and make sure they stay in shape once you put them down. It just takes an hour or so to dry properly. You can also use this slush to fill in some holes or gaps in your prints. It's also quite handy to fix some misprints or ugly spots here and there. Regular super glue works as well of course.

So now, my test kunai was sanded and glued together into one piece **[10]**. If I wanted to, I could have already started painting the piece at this point. If you prefer a high quality finish though, there are a few optional steps I would like to show you as well.



Extra smooth surface

The glue seams where your pieces were connected will still be visible at this point. I usually grab a cheap spot filler from my local hardware store (to fix wooden floors) and apply a bit of it with a soft spatula **[12-13]**. You can also use your ABS slush for this but I found this putty easier to sand off again. Once it becomes completely solid, I sand over it again with a 120 grit sandpaper and check my piece for any more visible layer lines I might have forgotten **[14]**.

There are actually a few different techniques and products you can use to get a smooth surface finish on your prints **[15]**. One of them is called vapor smoothing, which basically melts the surface of a 3D print with vaporised acetone. Just look it up on YouTube. I'm not a huge fan of it though, since it not only smooths the print lines, but you also lose all textures and fine details.

You can also apply a layer of Smooth-On's XTC-3D which will auto level into a nicely sandable surface. I don't really like this one either though as I find it too thick and messy to apply.

My favorite way is actually to apply a coat of automotive spray filler or spray primer. Applying a thin layer in a different color and then sanding it away again might also help you spot if there are any cracks or other imperfections in your surface. When everything is just gray it sometimes can be really hard to see. So it's always a good idea to have a few spray primers in different colors ready.

So, I applied one layer of spray primer **[16]**, let it dry for a few hours, and then sanded everything again with a 220 grit sanding sponge **[17, next page]**. If something needs to look really shiny though, like chrome metal shiny, I will also grab a super fine (1000 grit) sandpaper and wet sand the surface until it becomes even smoother. You can really go as far as you want so consider what you will need for your prop or costume piece for. Just be careful that sanding doesn't become a crazy obsession and you start dreaming of different sanding paper grits at night. Then it becomes weird so at that point you should probably stop sanding. However, this is the way to go if you want to get something really perfect. I however hate sanding and am happy when I get rid of the most visible lines. For my kunai I only did one pass with a 220 grit paper and called it a day. That's good enough, so on to the next job: Painting it!





Painting my kunai

For 3D prints, you can basically play around with any kind of paint your crafty heart desires. Unlike EVA foam, filament plastic isn't flexible and therefore you can paint it with all the fancy spray paints, shiny lacquers, chrome effects, airbrush paints or just simple and plain acrylics. No need to worry that they might crack. Once your plastic is sealed with primer, you also don't need to worry about any chemical reactions or weird behavior from your materials.

Still, it's always a good idea to do some test samples and not directly start painting on your pretty and shiny 3D model. Especially when you just spent a week sanding it smooth. Messing something up and then having to print, glue and sand everything again would just be a big pain in the poopy butt hole. If you need any tips on painting check out my two painting books "[The Book of Cosplay Painting](#)" and "[Advanced Painting - Airbrush and Weathering](#)".

I applied a layer of glossy black spray paint first and then airbrushed some Alclad chrome on top. Boom, metal! A bit of fake acrylic blood to the tip **[18]** and my first kunai example was done! Looks real enough, right?



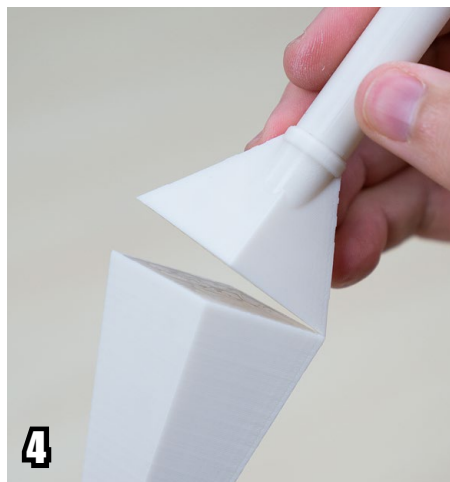
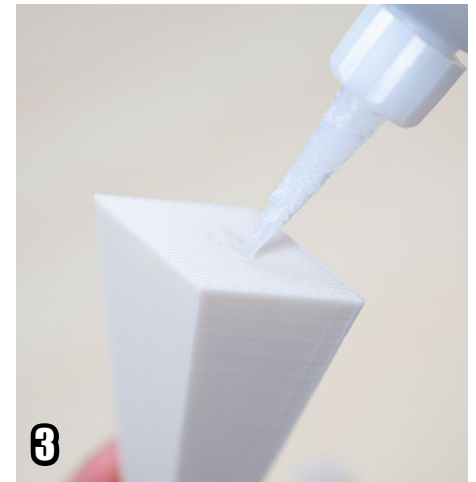
Differences for PLA

Even though PLA is a lot easier to print than ABS (no enclosed printer, no heated building plate), it's sadly not nearly as easy to sand smooth afterwards. It's not only a lot harder than ABS but also has a lower melting temperature. This brings with it a few disadvantages.

First you need to use stronger pliers to clip away the support material **[1]**. I have already broken the metal tips off a few of my pliers that worked just fine with my ABS prints. With PLA, you will need to use quite a bit of force to remove the supports, so please make sure to wear your safety glasses in case a small piece comes flying towards you.

Second, you cannot really melt the leftover support material in acetone to get a PLA slush. I mean it kind of works, but dissolving the material simply takes forever and the resulting slush doesn't really stick well. So instead, I recommend using super glue to connect your individual pieces **[2]**. Just put some of it onto one of your pieces **[3]** and immediately press them together for a few seconds **[4-5]**. The solvent in the glue will melt the surface of your PLA print and create a very strong bond between them. Just be careful not to get any of it on your fingers. This stuff is super nasty and will not come off again unless you use Acetone or sanding paper on your skin (which is really fun until it starts to bleed). On the other hand though, super glue sands really well so you can also use it to fill in some of the glue seams of your prints.

Also, since PLA has a lower melting temperature than ABS, using a sanding machine may actually make your surface even worse **[6]**. You will not be able to sand away much of the layer lines before the material will start to melt and becomes even nastier. It's frustrating! You can try to sand it by hand but unless you plan to spend several days on it, I wouldn't recommend it either.





So instead of taking material away like I would with ABS, what I do here is immediately apply a thick coat of automotive spray filler onto the untreated surface [7]. Then after it has dried, I can sand it down until I reach the original printing lines again [8]. Spray primer sands *a lot* easier than PLA. Now the only primer left will be between the thin printing layer lines which leads to an overall smooth surface. This may take a couple of passes until you get a smooth enough finish but hey, whatever works, works right?

When you're satisfied with your surface you can apply paint just the same as you would with ABS prints [9]. I started with a base layer of dark silver metallic spray paint, then masked off the edges with small curves to apply a brighter silver to the blade, and then I finally finished everything with a bit of dark brown oil paint weathering. Looks good! The only thing I would be careful with now, however, is not to let your prints lie around in direct sunlight. Like I wrote a couple of pages back, PLA already starts to deform at around 60°C and just a bit of direct sunlight from a window or in a car on a hot day may ruin your props. So be careful here!

Now that you've seen the differences between working with both materials, I have to say ABS is clearly my winner. Sanding the material and connecting all parts with the left over ABS slush is far easier. In addition I don't need to worry about warped plastic during a hot convention day. However, as I already mentioned, PLA machines are more affordable and might be a better starting point to get into 3D printing so it's a bit of a trade-off. There is also one more 3D printing material I want to talk about in this book, so let's continue to the next page.



Finishing resin prints

I also quickly wanted to show you the process of how to finish a resin print since it needs a very different approach to FDM printers. Since resin prints are almost perfectly smooth right out of the box, they mostly don't require as much sanding besides removing the spots where the support material was connected. Just getting to that point at all is a little bit more of a hassle though.

Contrary to the other spaghetti machines, resin printers slowly pull your 3D model out of a tank of liquid resin **[1]**. This resin is cured by UV light (or sunlight), which is why all of these printers have a UV resistant case over them while printing. As soon as your print is done you need to put on a respirator, open the lid and scrape your print off from the building plate **[2]**. It will still be a bit soft so a plastic scraper is enough for this. You should however do this immediately so the resin doesn't start to cure. As you can see, the print is still very wet and has a lot of liquid resin all over it. If any of these drops still remain on your surface, they will cure to the print and will be impossible to remove without damaging the rest. To get rid of them altogether you need to wash your prints in isopropyl alcohol (which is standard cleaning alcohol). I do this by filling the alcohol into one of these ultrasonic cleaners for eye wear glasses and letting it run for a few minutes. Works like a charm **[3]**!

I actually saw that there is a new type of resin now that is washable with water, but even if you use this one, I still urge you not to clean your prints over the sink in your bathroom. Printer resin does not belong in your local water supply.

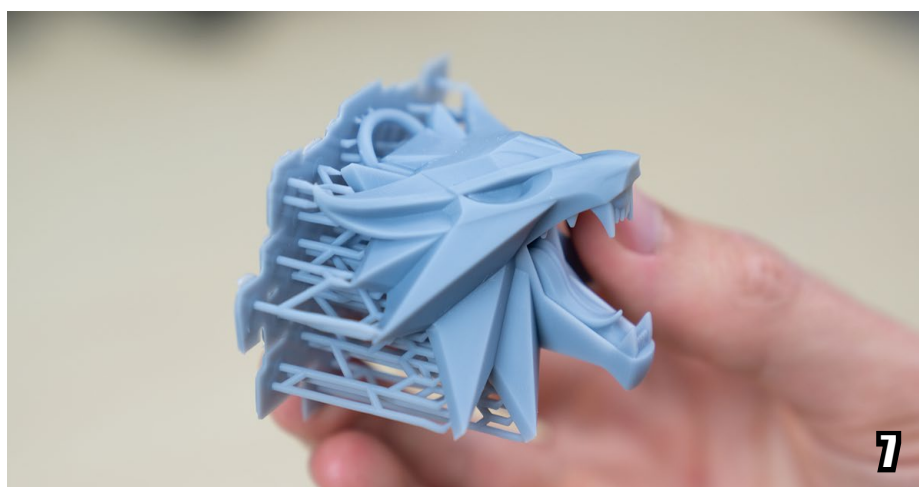
Then, unless you immediately want to start a new print, you will also need to thoroughly clean your building plate and resin tank with alcohol **[4]**. Luckily you can empty the remaining resin back into your bottle and use it again for next time. Just make sure to run it through a special resin filter (usually comes with the 3D printer or check out Amazon) so there are no hardened parts in it anymore. Then make sure to carefully scrape all remaining resin out of the tank and rinse it with more alcohol until it is completely clean and dry again **[5]**. You don't want any of the leftover resin to cure in your tank. Cleaning the tank and your printer takes a few minutes and is definitely the most annoying part of resin printing, but just as necessary as cleaning an airbrush gun. You can of course also put the alcohol back in the bottle and use it again next time.





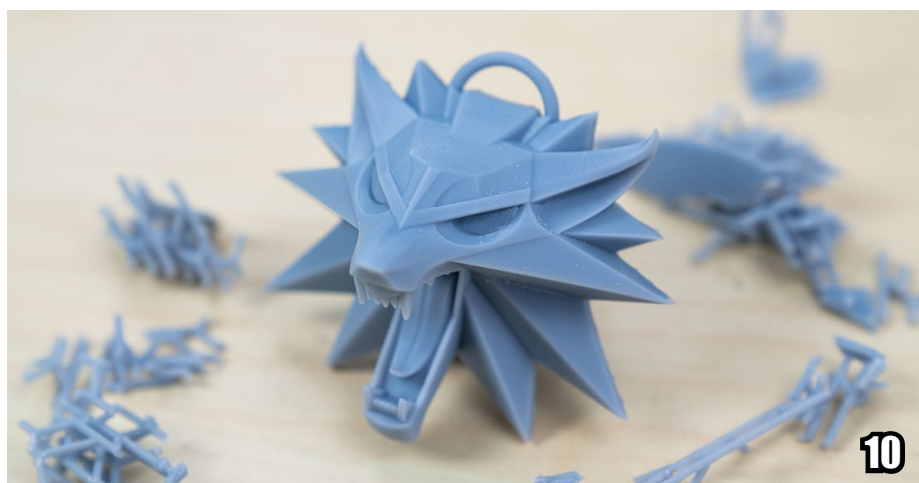
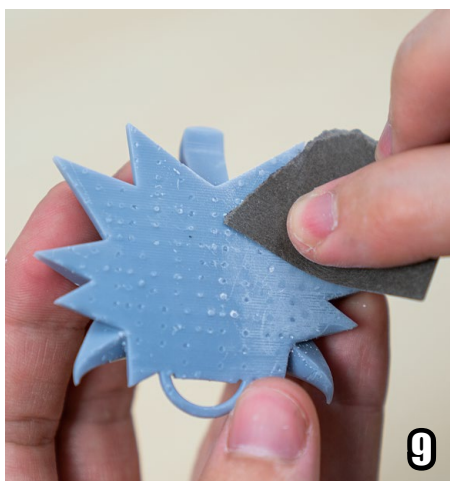
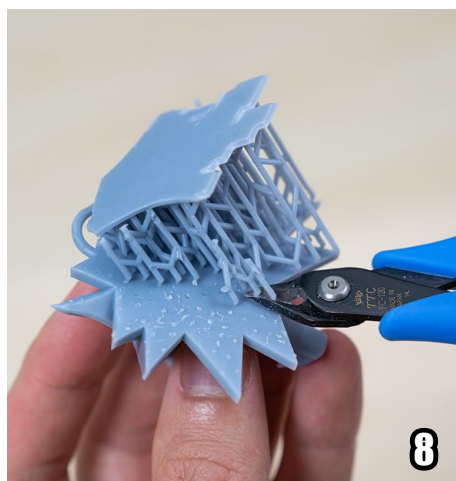
Once your printed model is completely free from liquid resin, take it out of the alcohol and cure it under a UV light for about an hour. For this you can either just place it in direct sunlight (and change the positions a few times) or if you're like me and don't want to depend on sunny weather, you can use an UV lamp. I bought one of these small nail polish curing things for this. When your print is cured, just take it out and you can finally marvel at the quality **[6]**.

As you can see, the quality of resin prints are just amazing. Out of the box, there are little to no printing lines visible. And you know what that means! NO MORE SANDING **[7]**!



Just clip away the support structures with your fingers or small pliers **[8]** and then use an x-acto knife or a small sanding file (okay, a little bit of sanding...) to remove the little support dots that are leftover. If there are any remaining ugly spots you can fix them easily with a fine grit sandpaper **[9]**. Resin sands really easy. And voilà! Your print should already be good enough to paint **[10]**.

I'm constantly blown away by the quality of my resin prints especially since these printers have become so affordable. It may not be the best solution for entire costume pieces, but for accessories and smaller parts, they are absolutely awesome!



NOTE

Did you know that these kind of printers actually work with flexible or even completely translucent resin as well? So, if you're like me and like to work with LEDs, why not print a few shiny gemstones or crystals?

So much more to explore

Now that we've talked about what 3D printers are, how to create 3D models as well as how to set up your slicer and finish your prints, I think it's time to look even further. What else can we do with 3D? What other techniques open up for us? Being able to work with 3D models can be incredibly useful for many other forms of costume creation as well! So let's dive a little bit deeper.

3D body scans

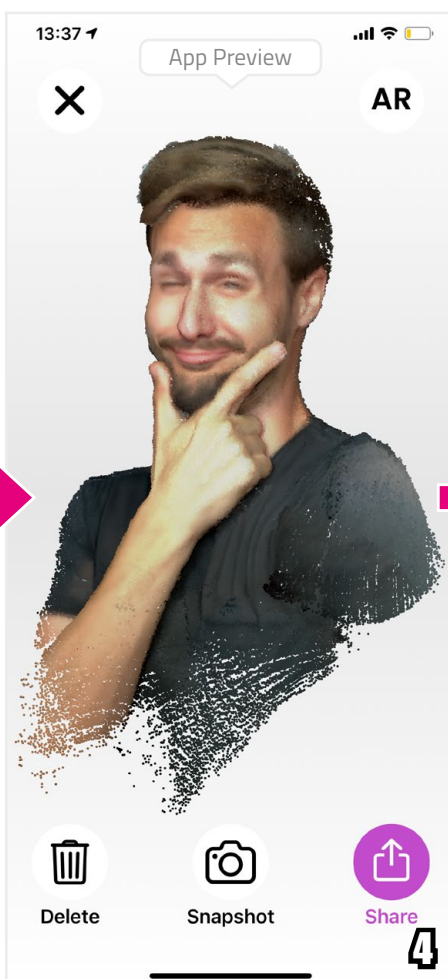
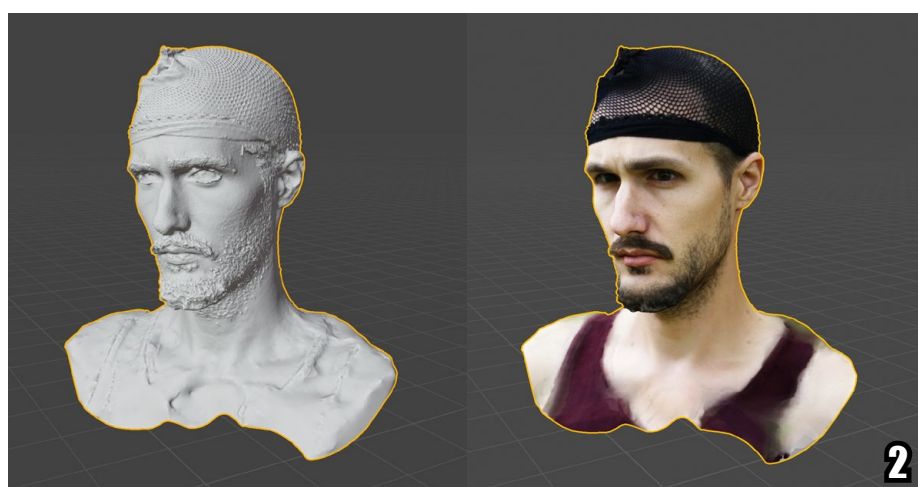
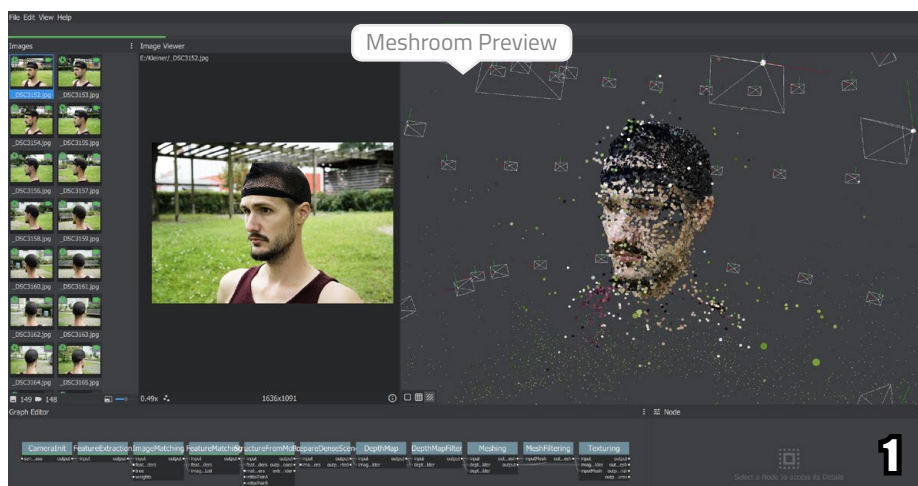
Having a digital 3D scan of your body can be an amazing advantage for your projects. Before I actually start printing anything myself, I always place my 3D models on a scan of my own body and check if the sizes and proportions are correct. There is nothing more annoying than printing a shoulder armor for 40 hours and then realizing the size is wrong. Having a real life sized model of your body means you can sculpt something directly onto any part you want, do a digital fitting for your armor pieces and props, or make proportion adjustments on 3D models you've found online. Lately I even begun creating full armor patterns in Blender and then was able to trace them directly onto foam - completely without wrapping myself in duct tape the traditional way. Long story short - it's really useful!

The very first 3D scan I ever got was made by a 3D scanning studio in Los Angeles back in 2014. I paid around 250US\$ for a pretty decent high quality scan, which was made by a person walking around me with a hand-held scanner. I just had to hold still for a few minutes and that was it! Five years later in 2019 I wanted to do a new scan since I had been working out and my body had changed significantly. I did a Google search and actually found a scanning studio here in our small town in Germany as well! This time I stood inside a booth with 120 cameras around me. All of them took a single image at the same time and then a program stitched the images together into a full body scan later. This 3D model cost me around 100€. The result had a lower resolution and showed less detail, but was still good enough to scale and sculpt armor pieces on **[right images]**.

In both cases I simply did a Google search for "3D body scan" and the name of a town or area. They may not advertise it, but companies that offer 3D printing services also often do full body scans. Just call and ask!

And by the way, I even printed the head of my 3D scan in actual life size since I didn't want to make a head cast. It's really useful for making all kinds of patterns, hats, wigs and so on!





Scans at home

Besides paying a company to do a scan for you, there is also a lot you can do with a simple camera or smartphone app. One way is to use a technique called "photogrammetry". Here you grab a camera (a smartphone will do) and walk around your subject while taking photos from every angle. Afterwards you can upload them to a free program like Meshroom **[1-2]** and it will create a 3D model out of them. As you can see, the test we did turned out great!

Another way is to use a smartphone app **[3-5]**. There are many different options like the "Displayland" app that lets you take a video of any object and then converts this into a 3D model. If you have a newer phone with a depth sensor (like the iPhone face scan feature) you can also use apps like "Scandy Pro" or "Capture 3D" that let you use your sensor (mostly the front facing camera) as a 3D scanner. While this still feels a bit wonky and the resulting model may not be perfect, it's still impressive what you can do at home for free. A model with holes or weird spots on it is still useful after all!



Pepakura patterns

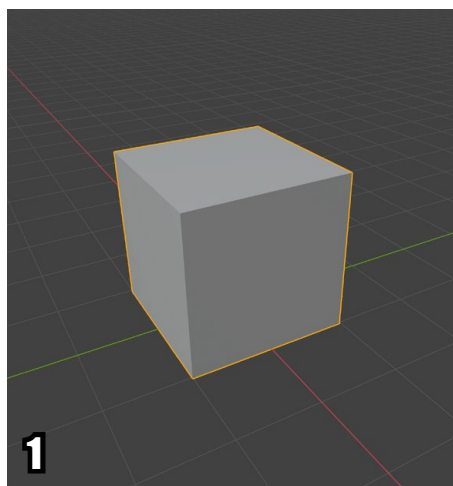
Turning your digital 3D model into a paper or foam pattern is another great use of 3D software. Just like you can unwrap a cube into a flat 2D drawing **[1-2]**, you can also turn any other 3D model into a flat pattern. It will just require a few more and smaller pieces. This process is called Pepakura and it's super handy for all kinds of awesome costume projects!

As a cosplayer you've surely already heard about Pepakura (sometimes called papercraft). If you Google search the term, you'll find amazing paper sculptures of Iron Man and Star Wars helmets, Skyrim armor pieces or massive Gundam statues. Most of these models are made with a program called "Pepakura Designer", which can "unwrap" any 3D model and turn them into a printable 2D paper pattern. What works for paper also works for foam though, so it's just perfect for cosplayers as well!

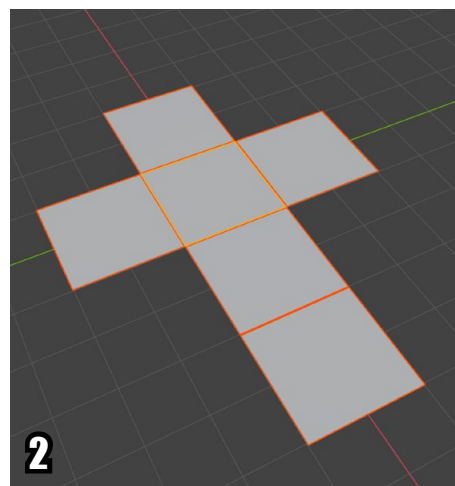
With Blender you can now make your own 3D models and then use Pepakura Designer to turn them into foam patterns. I use this technique quite frequently to create all kinds of crafting patterns for my store on kamuicosplay.com. Just recently I made a series of animal skulls for example **[3-4]**. These models don't even need to be very detailed as they actually work better the simpler they are. The traditional alternative would be to sculpt all of them out of modeling clay first, cover them with tape and then open up the tape to get the patterns. With Blender this step goes much faster though, without the need for any physical materials like clay or tape. It's definitely nice to have that option!

For one of my latest costume pieces for example, I needed a life sized Diablo skull. I didn't want to try and create a pattern from scratch with modeling clay and tape though, so Pepakura was just the perfect solution here. I searched for 3D models of Diablo online and luckily found one that looked perfect **[5]**. The model was highly detailed however, this is not great for Pepakura. For the unwrapping to work properly the model needs to have as few details as possible. So I had to sit down first and spend a few hours to "retopo" the model and make it simpler. "Retopology" is the name of a process where you create a simpler version of a model on top of a more detailed one. So I got rid of all the unnecessary textures and non essential details and only tried to follow the most basic shapes **[6-8]**. I already recorded a video explaining the process if you're interested.

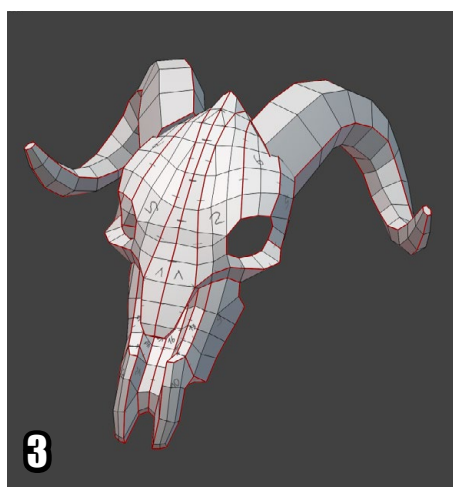
Check out my "retopology" video tutorial:
<https://youtu.be/wRBk9nplevQ>



1



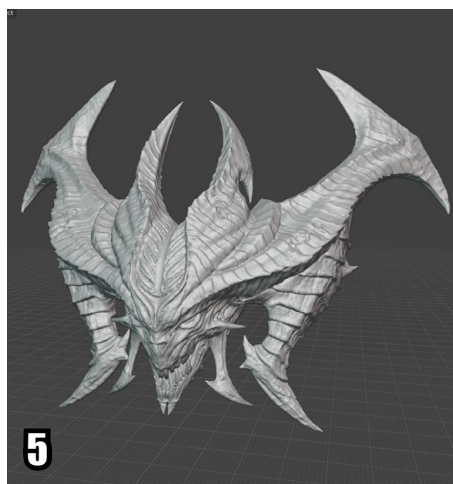
2



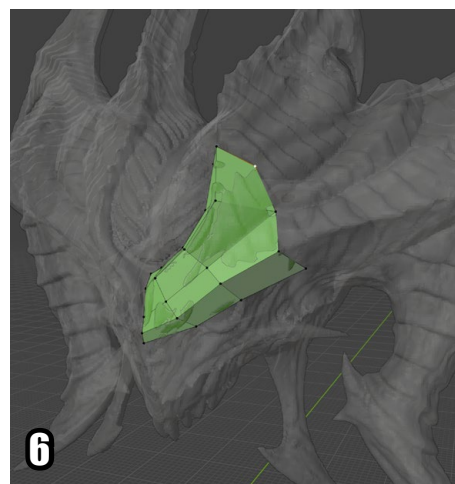
3



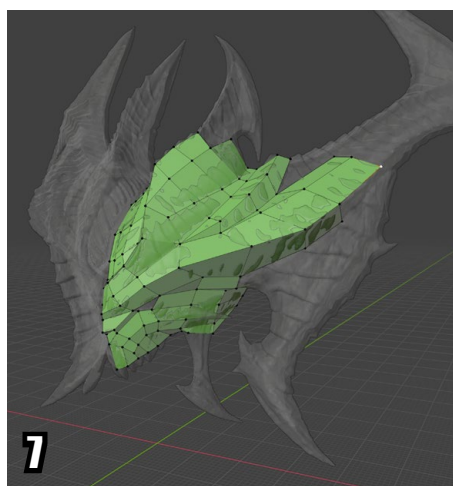
4



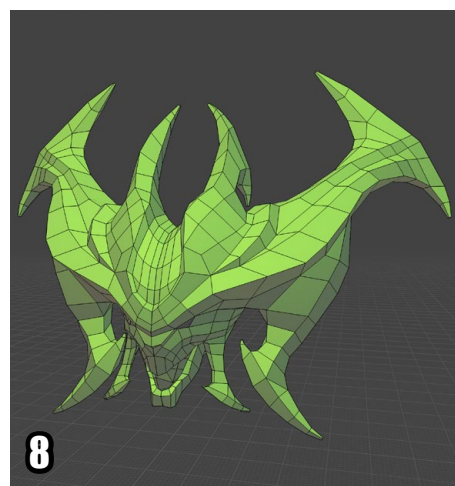
5



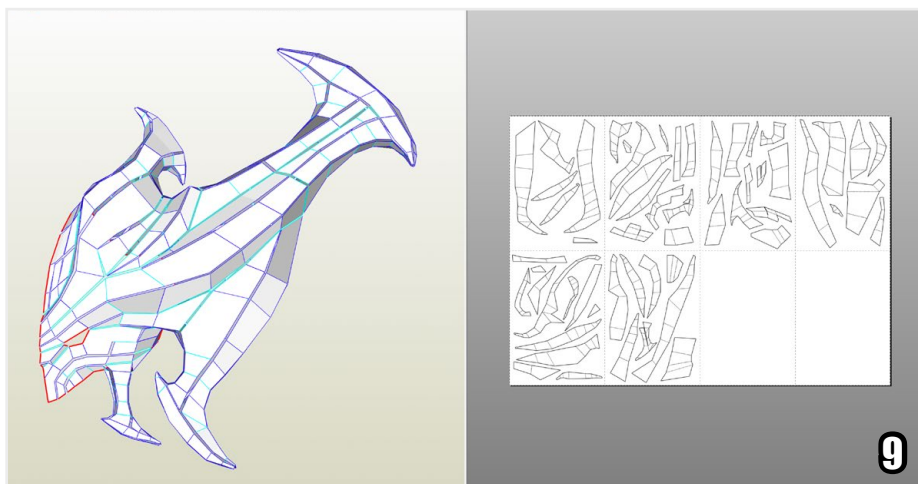
6



7



8



After I was happy with my model, I saved it as an .obj file (.obj and .stl are the standard file formats for 3D models) and opened it in Pepakura Designer. Here I marked the seams I wanted the program to cut along, clicked on “unwrap” and placed the resulting patterns on a few A3 pages so I could print them out at home [9].

Next, I simply traced piece after piece onto 5mm EVA foam and began cutting them out [10]. Compared to thin paper, EVA foam has a thickness, so I had to cut some of the edges at different angles to glue them properly together. Every time I cut out the next piece, I looked at my 3D model in Blender again to make sure I would make the right cut. This was a little bit annoying, but once I finally had everything cut out and glued together, the result looked like an exact copy of my digital Diablo head [11-12]!

Just like with 3D printing, it’s really magical to see a digital model come to life with Pepakura. If you’re curious about what I did next to finish the Diablo head, just check out the making-of video for my Demonic Brigitte shield.

Watch my full Brigitte shield video:
https://youtu.be/Ku2_91NZPZ8



Iden Versio armor

To be honest, I probably used Pepakura more in my recent costume projects than actually 3D printing something. Being able to turn a 3D model into super accurate foam patterns is awesome – especially when printing the same model would have resulted in a piece that would have been too heavy to wear all day.

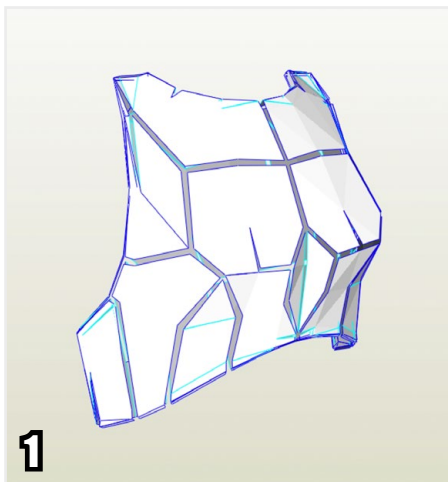
My Iden Versio costume from Star Wars Battlefront was one of my very first Pepakura projects. Originally I tried finding armor and a helmet that would fit my size to buy. You know, it's Star Wars, it shouldn't be so hard? Sadly I only found these ugly and huge one-size-fits-all plastic pieces on eBay. So I decided to create everything custom made for my own measurements. You know, if you can't buy it, make it yourself!

So after some quick Google searches, I found a Pepakura file for a standard Stormtrooper breastplate. It wasn't exactly what I was looking for, but good enough to be able to make some adjustments [1]. Back then, I already used Blender and had my full body scan to figure out the right size for my Pepakura patterns, so I scaled them to what I needed and printed them out on paper afterwards. Before copying everything to EVA foam though, I actually built the whole paper dummy first [2]. This was incredibly helpful to make sure my resulting breastplate would fit onto my torso.

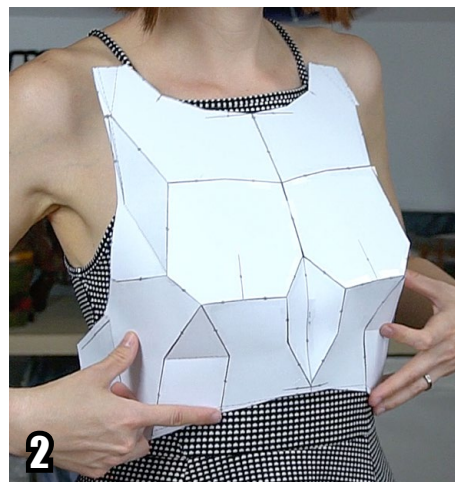
Next, I cut out all pieces again and traced them onto 5mm high density foam. I glued all parts together with contact cement [3], applied a black spray primer (PlastiDip) to seal the material [4] and finished everything with another layer of airbrush paint and protective varnish. The finished breastplate front and back [5-6] now had a perfect fit and looked amazing on the costume.

Despite me having no idea how to deal with Pepakura and the correct sizing in the beginning, it was clearly worth a shot. I learned a new skill and made something cool with my own two hands. At the end, this felt much better than getting a store bought costume without a proper fit.

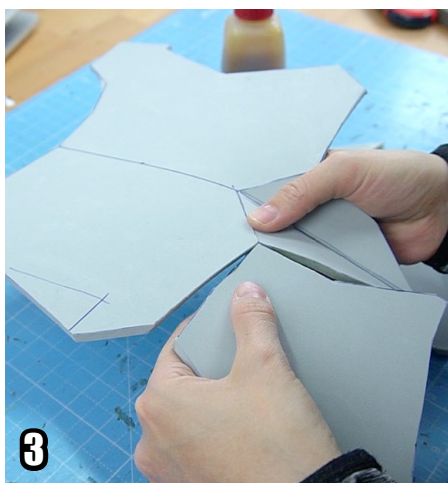
Watch the full building process here:
https://youtu.be/jb4sdH_UZi8



1



2



3



4



5



6



Anthem Javelin helmet

The Javelin helmet from my Anthem costume was quite challenging as well. Here, I started with a very detailed 3D model **[7]** and wasn't sure if I should just print it or use the Pepakura technique instead. But to be honest, while 3D printing is amazing, sometimes I also really enjoy crafting something with my own hands. So again, I used Blender, loaded a 3D head scan and made sure the helmet would actually fit **[8]**. As was shown, you can do these kind of scans easily with a smartphone and a free app yourself. Just try it out, it's super easy and really helpful, especially when it comes to building helmets and other head gear. I didn't plan to actually wear the helmet, but it was still important to me for it to look like it would fit.

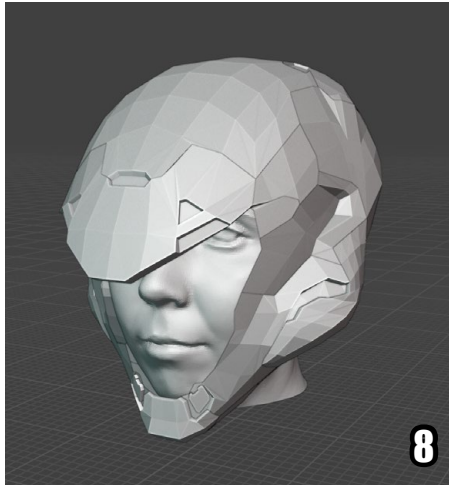
The original file obviously had far too many details and tiny elements to use it for Pepakura, so I redid the topology here as well to get a far more simple 3D model. Doing this was a little bit tricky though, since the original design had plenty of raised and lower areas, but I decided to keep them flat and to recreate them later with different foam thicknesses. The resulting Pepakura pattern was still a gigantic, messy puzzle **[9]**. To set it back together, it helped to look at the assembled in Pepakura designer as a reference and constantly check how the final version was supposed to look **[10-11]**. The whole helmet remained pretty unstable for a long time and I didn't really think this technique was going to work for it. Once I connected the bottom though, it became much more stable and then finally held its proper shape. Finally, after this part was done, I began adding all kinds of details and tried to rebuild the look of the original 3D model **[12]**. Once completed, I applied a layer of flexible primer (PlastiDip) and added a nice paint job **[13]**. The Anthem helmet was clearly a very challenging project and I had my doubts, but once done, the Pepakura technique showed me again how awesome 3D modeling and foam smithing can actually work together.

See the process in more detail here:

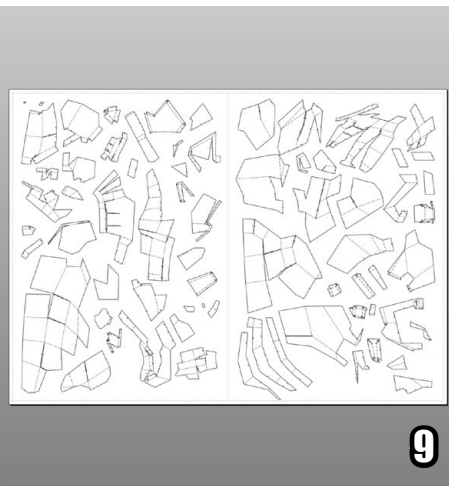
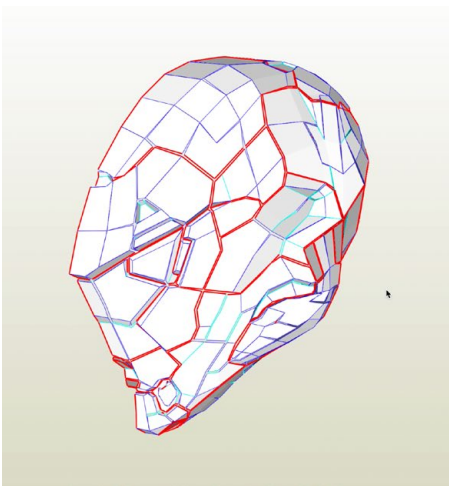
<https://youtu.be/oVn3kxsvHkQ>



7



8



9



10



11



12

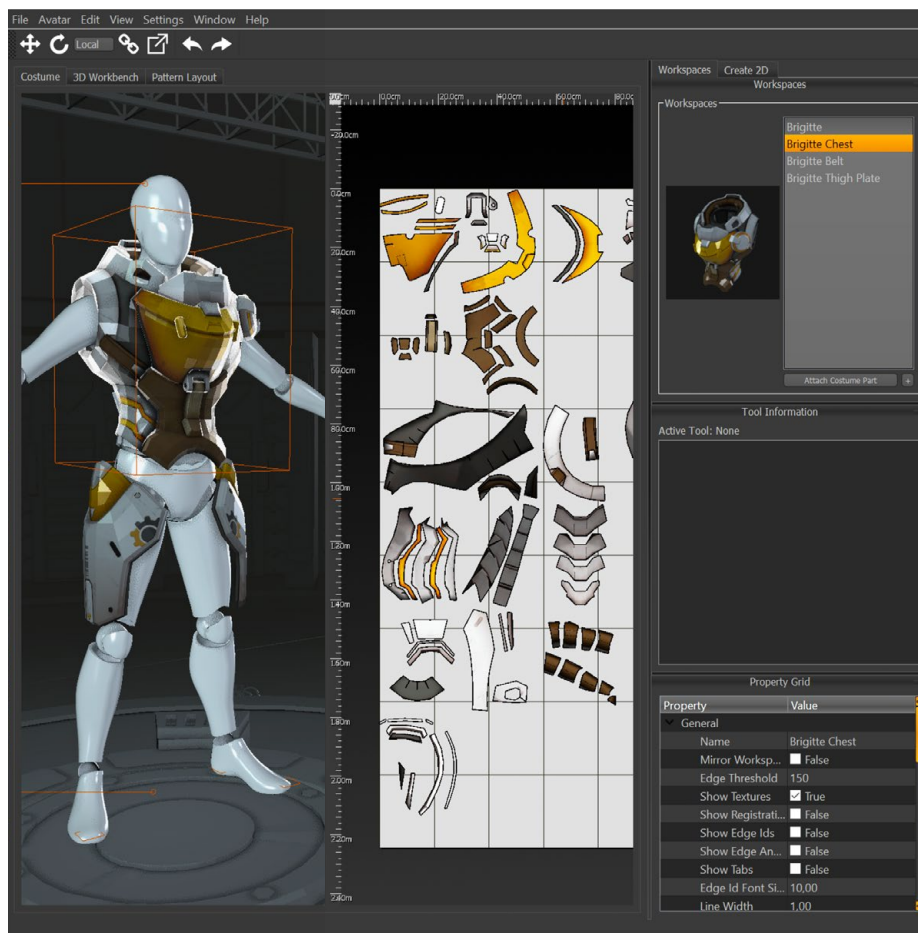


13

Armorsmith Designer

I also quickly wanted to mention two more cool programs you can check out. The first is "Armorsmith Designer". This software was specifically created for armor crafters like you and me. Imagine Pepakura Designer but with a lot more functions that are useful for cosplayers. It allows you to build a digital mannequin of yourself, complete with all necessary measurements and then lets you "try on" 3D costume pieces. These parts can be Pepakura files or any other 3D model from the Internet or made by yourself. Just load up a model, select the body part to attach it to and then edit the position, rotation and scale until it fits. The finished piece can be unwrapped into a flat paper pattern (just like with Pepakura Designer) and sent to your printer. No more wondering if a piece *looks* big enough.

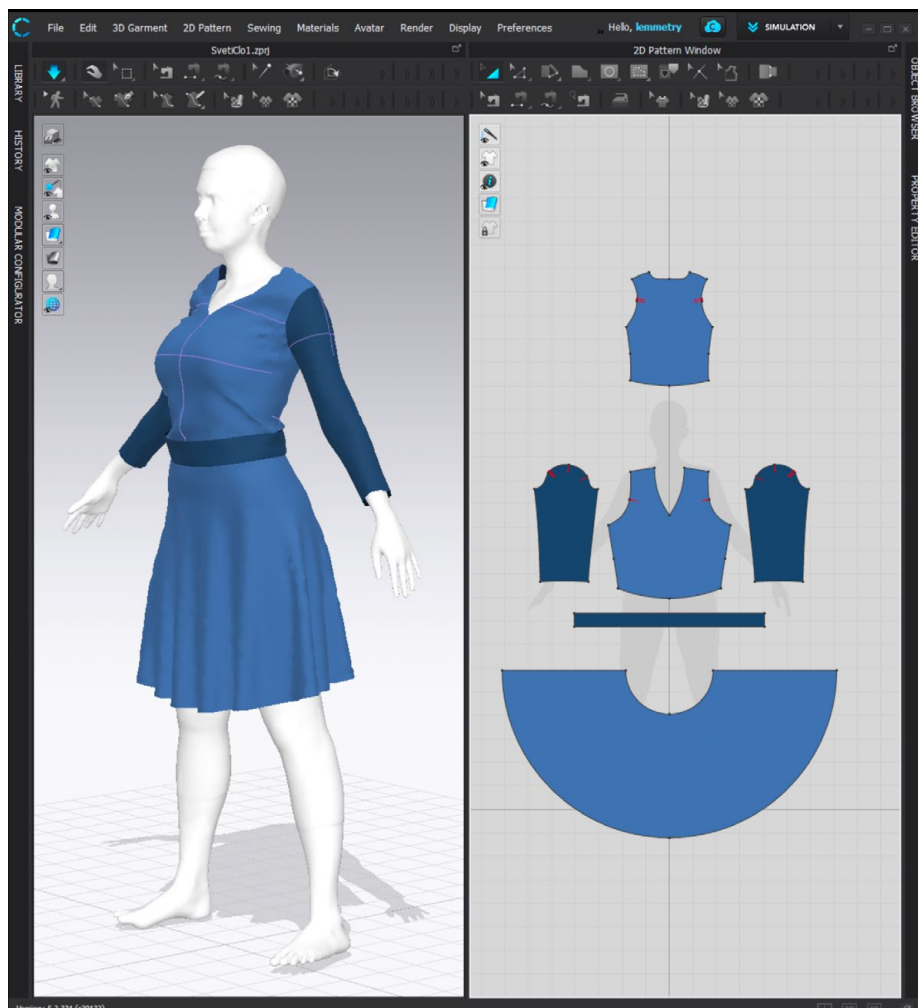
So, if you ever had trouble finding the right scale for your armor pieces, you should give Armorsmith Designer a chance. It's well worth the small fee (30US\$) but sadly only runs on Windows machines for now.



Digital sewing patterns

"Clo3D" is another amazing program. I haven't spent a whole lot of time playing around with it yet as I usually don't do many sewing costumes, but it basically works like this: You draw or import 2D sewing patterns and then place them on a digital mannequin. This avatar can be sized to your own exact measurements - or even better - just load in your 3D scan like I did! Then in a matter of minutes I was able to create a lovely dress (not perfectly fitting yet, I know) and play around with it until I am satisfied. It lets you work with different fabrics, stretches, stitches and pretty much everything you can imagine like a real sewing project as well. It allows you to draft complete outfits and costumes but also individual pieces like blouses, dresses or pants.

I could probably fill a whole book with only this program but I will leave this for you to discover if you're interested (this is a 3D printing book after all). I think it's a great program for anything sewing related. It also does cost quite a bit (around 50US\$ per month) but you can also get a trial version for 30 days if you just want to play around a little bit. It's absolutely fascinating what technology and cloth simulations are capable of today.



So far so good! That was a lot of theory!

I think now it's time to show you some proper hands-on examples of 3D printing and modeling in action!

On the following pages I will show you some personal projects that document my own growth and progress in 3D printing from small props and tiny accessories to full armor costumes. I hope this will show you that even though you may have no clue what you are doing now, you can achieve anything you want if you just give it a try.

Fallout 4 Pip-Boy

Building a Pip-Boy from the game Fallout 4 **[1]** was one of the first 3D printing projects I tackled after buying a printer. It's also a great example of what you can do with a printer without any modeling skills. I actually found this ready-to-print 3D model completely for free on the website ytec3d.com **[2]**. The artist made an amazingly detailed replica of the in-game model, separated the file into various parts and even added a very detailed assembly instructions - including the size and amount of screws necessary. This was so incredibly helpful that I could not believe someone spent so much time on it and then uploaded it for free. So, thanks so much Yvo de Haas!

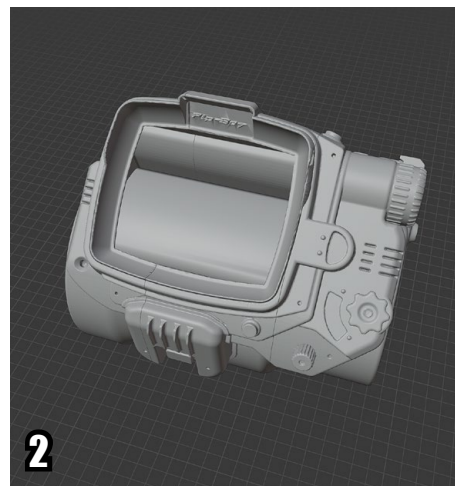
After I hit download, I got a great set of individual 3D files that didn't need any additional work and could directly be sent to my Zortrax machine. It was quite a lot of pieces so printing still took a while **[3]**. Once all parts were done **[4]**, I began sanding everything piece by piece. First with my triangle sander **[5]** and then by hand with sandpaper and files. I printed everything in gray ABS so sanding was really no problem. This step was still clearly quite tedious, especially since the set consisted of around 40 individual parts, so I put on some Netflix on the side and zoned out for a bit.

Next I grabbed a tooth pick and applied some ABS slush to the parts I had to glue together **[6-7]**. Now that everything was smooth and glued together, I used some grayish green rattle-can spray paint to apply a base color and then took my airbrush and a darker green to add some darker shadows on top **[8]**.

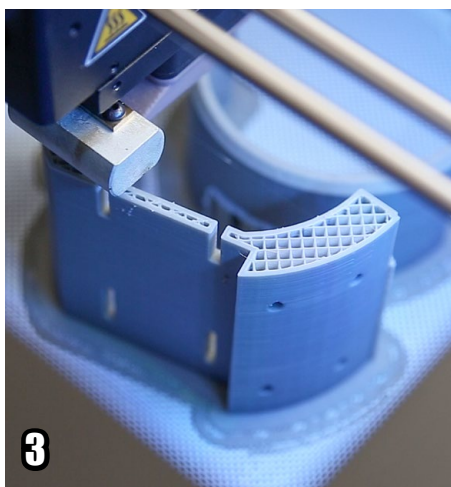
I actually didn't apply any automotive spray filler this time. The Pip-Boy was my first 3D printing project of this scale and I didn't know how to properly get a good finish yet. However, since the final paint job was supposed to make this prop look old, ugly and weathered anyway, I think it actually helped in this regard.



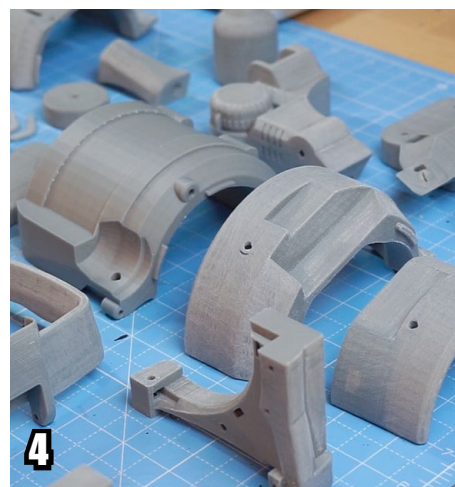
1



2



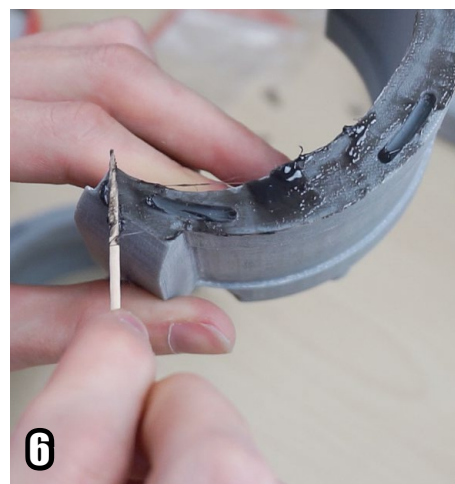
3



4



5



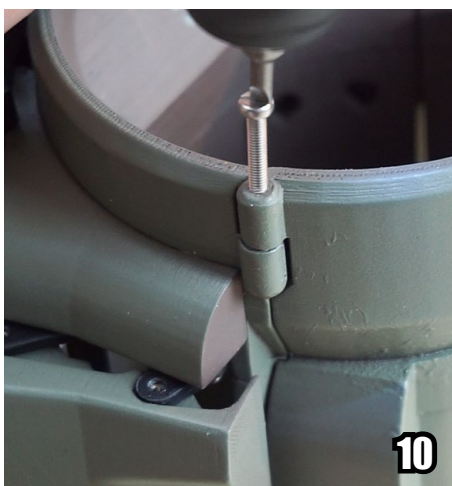
6



7



8



After all the pieces had gotten their coat of paint, it was finally time to piece this whole puzzle together. This step was a little bit tricky, but the instructions on the website were super helpful here. I was actually really impressed that my 3D printer was able to print working screw holes that perfectly fit the necessary screws in [9-10]. One screw here and one screw there and the Pip-Boy had a working hinge to open and close the prop.

And finally, after everything was properly assembled, I applied some weathering to make the prop look more believable [11]. It was actually designed in such a way that I could put my smartphone inside and get a working Pip-Boy screen as a result. It looked pretty awesome!

I did later exchange the smartphone for a printed static screenshot of the display. Not being able to use my phone for the whole convention day was not the greatest idea, haha.

Watch the whole Pip-Boy making-of:
<https://youtu.be/CLPelIdYTNs>



FFXIV Monk - Brooches

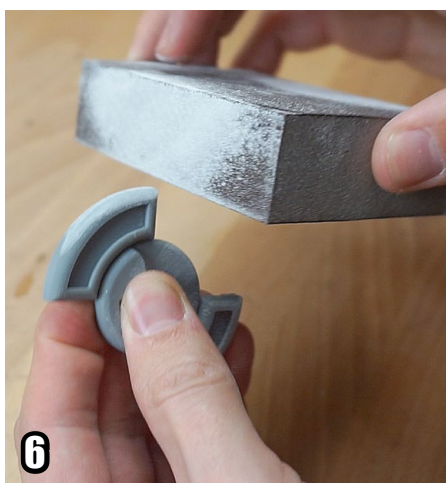
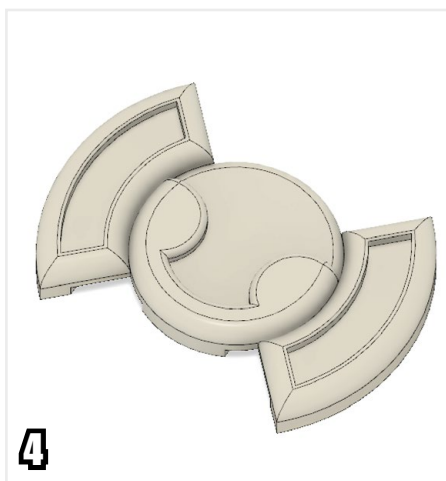
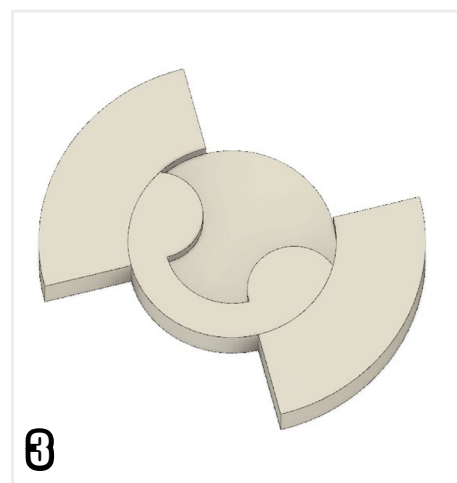
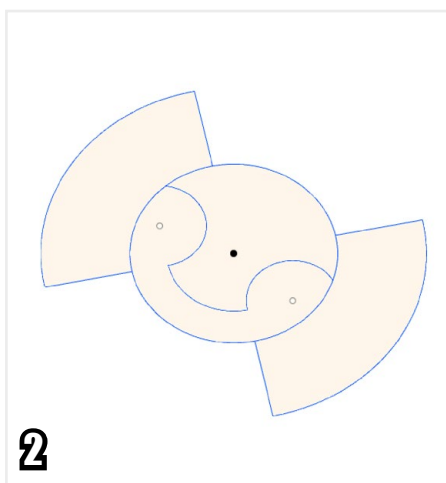
For my next 3D printing project, I wanted to raise the stakes a bit and make my own 3D models. I needed a few very simple looking brooches and accessories for my Monk costume from Final Fantasy XIV, so I thought they would prove to be a great opportunity to test my Fusion 360 skills. It's of course possible to make smaller details like these with Worbla, EVA foam or even molding and casting but hey, you gotta start somewhere, right?

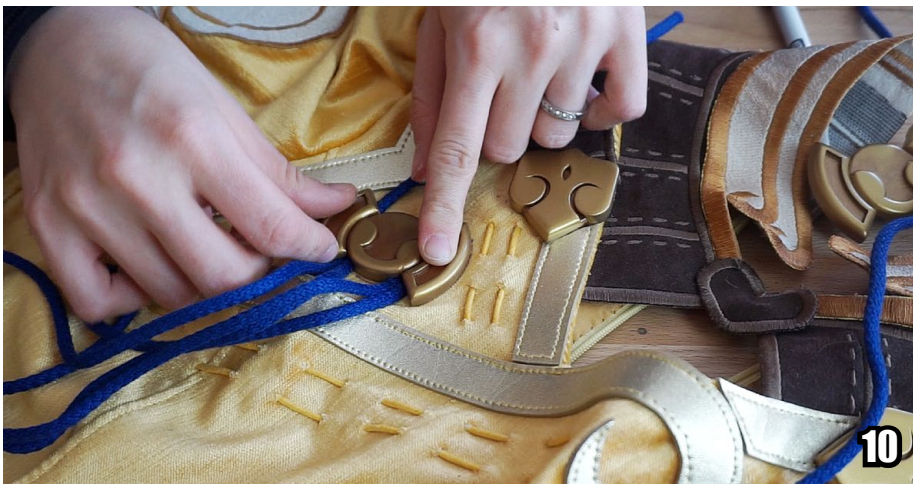
For my reference I was lucky enough to find a 3D model viewer of the in-game characters and armor sets. Actually, you would be surprised how easy it is to find 3D models of your favorite characters on the Internet. There is always a fan somewhere who takes apart a game and uploads the 3D models, skins or even the whole world to their website. I used the World of Warcraft Model Viewer already ages ago when I worked on my very first costumes and so I was excited to find something similar to FFXIV.

The 3D models though sadly weren't all that high resolution, so I still had to improvise a bit and guess most of the shapes [1]. I started with a 2D sketch of what I thought the shapes would look like based on the image [2]. Then I selected the individual parts and raised them up into 3D space at different heights [3]. Last but not least I indented the centers of the outer wings, then selected the edges and told Fusion 360 to make them rounded (this option is called "fillet"). And I guess that was pretty much all [4]. It really wasn't the most complicated shape and I was actually kind of surprised how quickly I was able to put them together. Next I just sent them over to my 3D printer. The good thing is, that since I needed multiple copies of them, I could just print them out again and again with the same quality [5].

Back then, I only had one FDM printer, so I had to sand the pieces next. I did the exact same steps I already showed you on pages 21-24, so check back there to see it in detail [6]. Today I would 100% print these brooches on my resin printer, since the quality is so good that I could have painted them directly after printing. However, it wasn't an option for me at the time though.

Next I grabbed some golden airbrush paint from Vallejo and applied two thick coats of it to my smooth and sanded brooches [7].



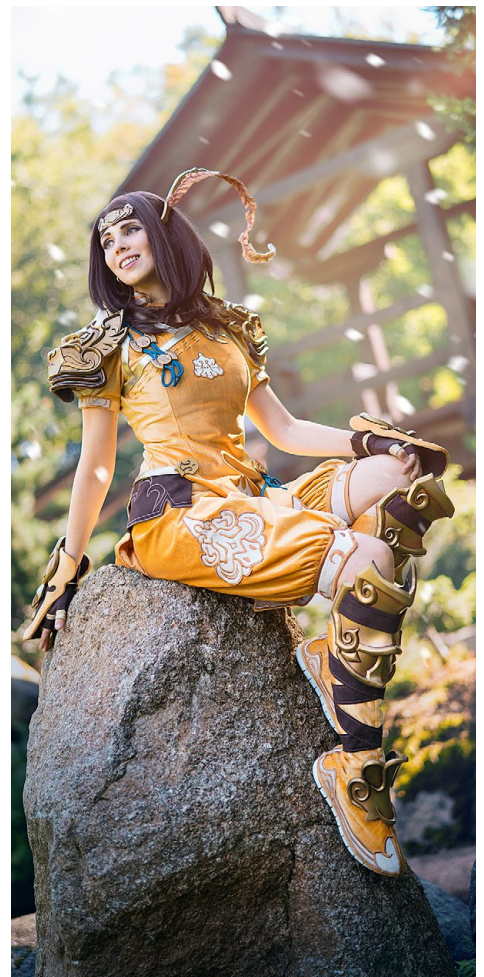


In total, I modeled and 3D printed three different brooch designs which didn't take me longer than a couple of hours each to model and to print [8-9]. To attach them to my costume I simply used fabric glue on the back and stuck them directly on the dress [10-11].

I know these little accessories may not look like much but I was actually very proud to be able to design and print small pieces like these myself. I spent a lot of time learning Fusion 360 and watching tutorials on YouTube to get to this point. Just looking at the Pip-Boy I downloaded and printed in my last example, I never dreamed of being able to make a model like this myself. Now though, I had taken my first step in that direction and was already hooked.

Time to move on to something a little bit more complicated for my next project.

Watch the whole FFXIV Monk making-of:
<https://youtu.be/2urF0miScXk>



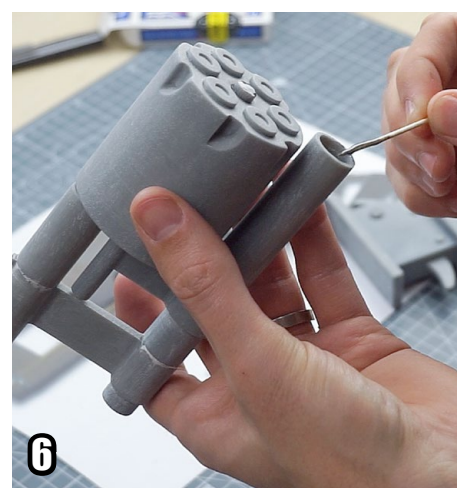
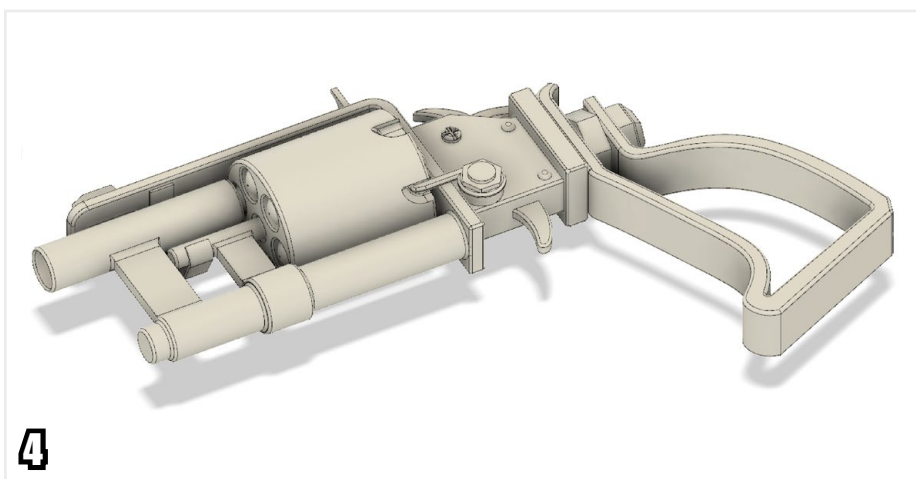
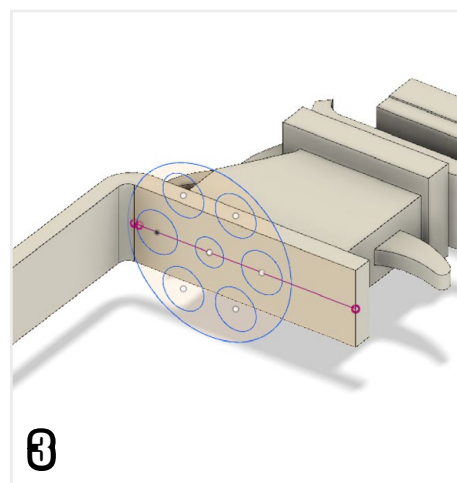
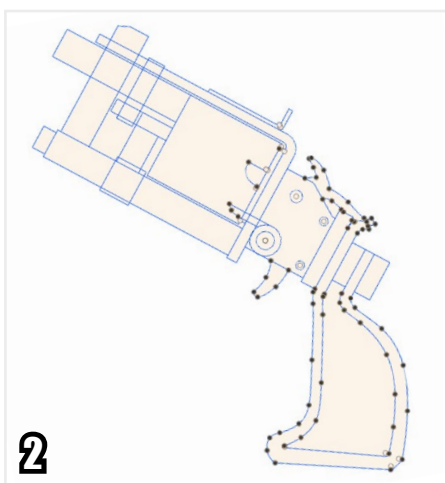
Fallout 4 - Pipe Revolver

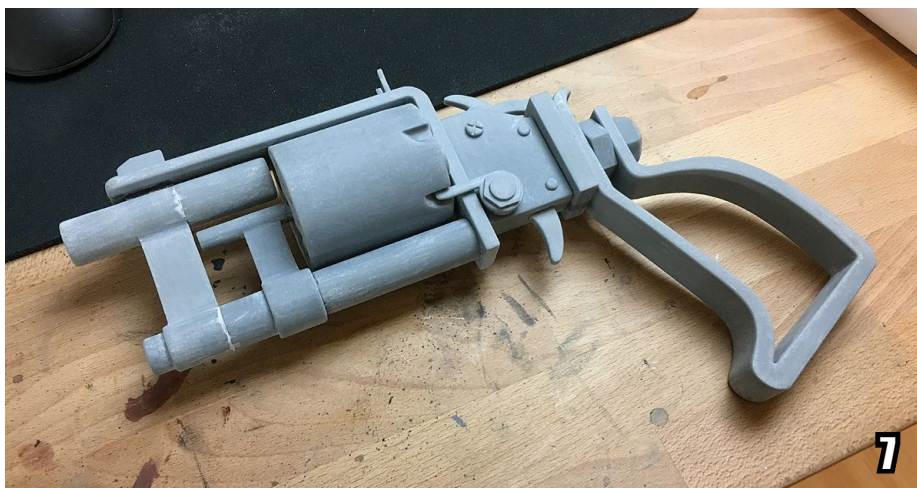
After getting a confidence boost from building my Monk accessories, I wanted to build something more complicated. I was super into Fallout 4 at the time and thought one of the weapons from the game would be the perfect practice. So I flipped through all the gear I'd got in my in-game item menu and finally settled on something that looked like I could actually manage to build - the Pipe Revolver Pistol **[1]**. It mostly consisted of simple geometric shapes (perfect for Fusion 360) but also had a few parts I would need to figure out first.

I opened up Fusion and loaded in a side view screenshot of the pistol I took in the game. Then just like with the Monk accessories, I began tracing the shapes to create a 2D sketch **[2]**. This worked great for most of the shapes but stopped being useful when it came to the pipes and the cylinder in the middle. A cylinder from the side is just a rectangle, so I had to start building additional sketches from the side view. The good thing about drawing blueprints in Fusion 360 is that they do not all need to be on the same layer. You can place them anywhere you want! On the ground, sideways, or even on top of another object. So for the cylinder I created a round sketch with revolver holes which was placed sideways on the middle part **[3]**.

I was actually surprised that I was able to finish the whole 3D model without encountering any problems **[4]**. The whole process was very straightforward and only took a few hours. It really looks more complicated than it is. Simply making the small Monk brooches from before had already taught me enough to build this thing as well. Crazy right?

Now I was super excited and began printing out all parts as little individual pieces. In hindsight, it would probably have been smarter to combine a few of them into bigger ones before printing, but you're always smarter after the fact, right? I sanded everything first with my triangle sander **[5]**, and then by hand with a sanding sponge. After I was satisfied with the surface, I used my ABS slush and a toothpick again and glued all the little individual pieces together **[6]**. This step would definitely not have taken as long if I had combined a few of the pieces in Fusion before printing. But hey, at least it was easier to sand them this way.





Painting the assembled revolver was easy enough [7]. I applied a base coat of silver spray paint first and then a layer of hair spray. Why hair spray? It will prevent the next color from sticking too much to the layer underneath. I took my airbrush and applied a brown on top. Now I could scratch off the same paint again with a toothpick whilst the hairspray protected the silver underneath. Cool right [8]? This way I could apply dirt and grime and still make it look like the original material underneath was metal instead of 3D printed plastic. I really liked the finished paint job.

I learned a lot from finishing this prop - plus it was super fun to put together! If you want to give it a try as well, you can actually download the 3D files from my website for free.

Now that my confidence had reached unholy levels, I thought it was finally time to tackle a full costume project!

Watch the full Pipe Revolver video:
<https://youtu.be/NRTvCcN6OWg>



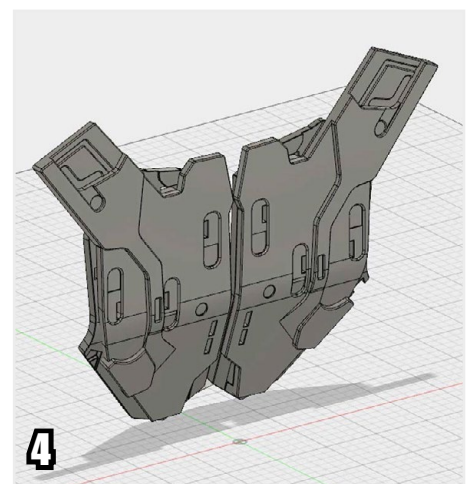
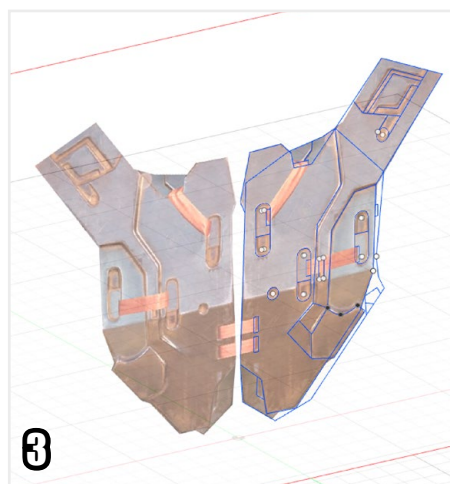
HZD - Aloy Shadow Stalwart

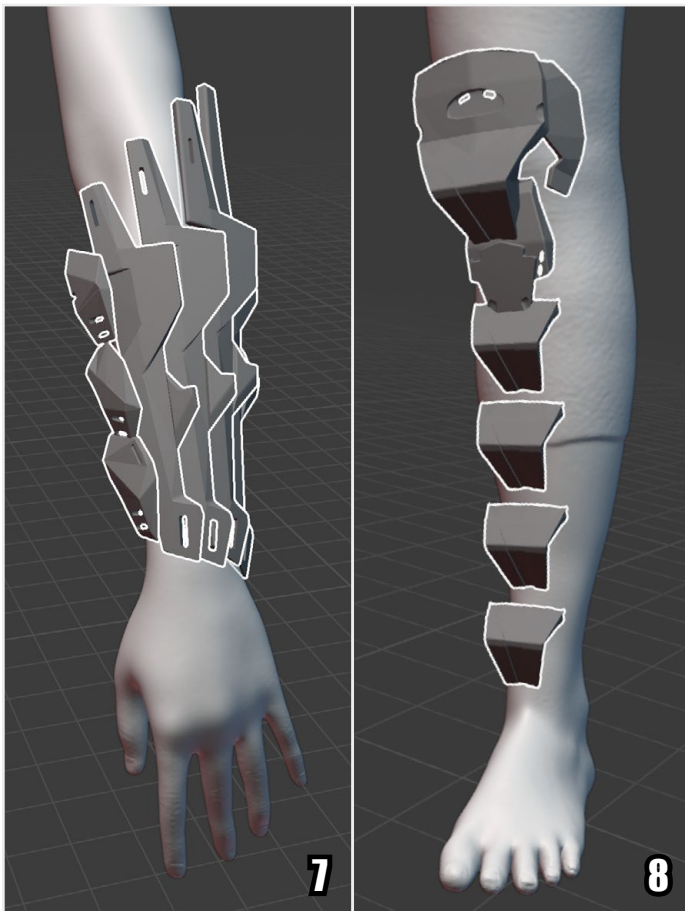
Aloy's full plate armor from Horizon Zero Dawn was probably one of my biggest projects. With my newfound knowledge in 3D modeling, I created around 230 individual armor elements based on 30 different designs made almost entirely in Fusion 360, just by looking at some screenshots from the game's photo mode. This costume was one gigantic puzzle, but also proved to myself that it's possible to 3D print an entire costume.

I considered using a lot of different materials for Aloy's armor at the beginning. While EVA foam or Worbla would have worked, I was worried that especially the thin and long elements of her costume would be too wobbly. In addition, to creating so many individual, and very detailed elements by hand would take me an eternity. Plus I wasn't sure if I would even be able to work that precisely with either foam or Worbla. So I decided to just 3D print the whole damn thing! Printed plastic would be strong, durable, lightweight, and look clean and factory made - which would fit very well in the world of Horizon. After all my previous 3D printing and modeling projects, I was now also confident enough that I could actually pull it off.

Getting good reference material was probably one of the hardest parts of this project. Aloy's armor consists of hundreds of separate little armor plates, just like a second skin of scales all over her body. To be able to 3D model all of these parts, I needed reference images of each of these pieces from multiple sides. Therefore I took countless in-game screenshots (thank god for photo mode) and tried to catch every single element and detail [1]. I then began printing out the front view of each piece onto paper and pinned them to the leather under armor I sewed earlier [2]. I tried to complete this gigantic armor puzzle on paper first, so I could see all the elements I needed. Only when I was confident that the proportions were correct, I moved on to the actual 3D modeling in Fusion 360.

I loaded the screenshots into the program, began tracing all the shapes to create the blueprints I needed [3] and then slowly turned them all into 3D models [4]. This way I was able to directly build one armor scale right after the other. The breastplate alone already consisted of 22 different parts. I printed one piece after the other and slowly replaced every paper dummy on my mannequin with a 3D printed part until the whole breastplate slowly came together [5]. It was very satisfying to see the puzzle grow before my eyes. Sanding and painting the pieces was child's play after this [6].





During the time of this project, I also made my first baby steps into 3D modeling with another program I hadn't touched before: Blender! While Fusion is great for pieces based on simple 2D sketches, Blender allows for more free-style modeling. I struggled a lot trying to figure out the sketches for many of Aloy's more complicated arm and leg armor pieces so I was searching for a different approach! After watching tutorials and reading recommendations for other software, I decided to give Blender a go. First it was a little

weird switching from one modeling program to another since the controls were slightly different. However, I was surprised how far my basic Fusion knowledge already got me. Jumping from one program to another was really not so bad. In Blender I could finally directly manipulate every single point, line and plane of my 3D objects. I was no longer bound to any drawings! Freedom!

With the power of this new program at my fingertips I loaded in my 3D scan and modeled the

remaining pieces one after the other [7-8]. Then I printed them out, sanded them and painted them. Afterwards, I finally put them all together onto a table so I could see where I was with my overall progress [9].

In total I ended up modeling 30 different armor parts, 3D printed around 100 copies of them and even made a few more by hand.



NOTE

The attachment for all armor pieces was actually very easy. I took a small drill and drilled some holes into the armor pieces. Then I simply took a curved needle and a sturdy thread and sewed them directly onto my faux leather armor. From a meter away these attachments became pretty much invisible! The result looked really good, had a nice weight to it and even sounded like real armor when I walked with all the clicking and clacking.



Aloy's head gear was clearly the most challenging piece of the costume [10]. While it was pretty straightforward to create all the previous armor parts in Fusion and Blender by myself, I encountered a road block when trying to make the head piece - at least with my present 3D modeling skills. The round shapes were simply too weird to be built from a flat 2D sketch. The deadline was approaching fast and every time I tried a different approach I ended up in a dead end. So for this part I actually commissioned my brother Jakob, who studied 3D modeling - and

yes, I also pay my family members for their work! Jakob sat down for a day or two and created this amazing model of the helmet in Maya, which is a modeling program similar to Blender [11]. For easier printing, I split the front piece in two and then sanded and painted all of it [12-13]. I also added these little side wings which I made by hand using PVC sheets. Looking back at the whole head gear now however, I would definitely sculpt this piece by myself. A few months of practice can make all the difference! I might still take longer than someone

who studied all of this in university, but I'm pretty sure I would be able to figure it out in the end. I have built more complicated pieces since then.

So now all my armor parts were done and I was almost completely finished with this project. The only thing missing was a proper weapon to go along with the costume.

By the way, you can see the entire building process of this costume in this video series:

<https://youtu.be/OkTzylY4ppU>

A “working” 3D printed bow!

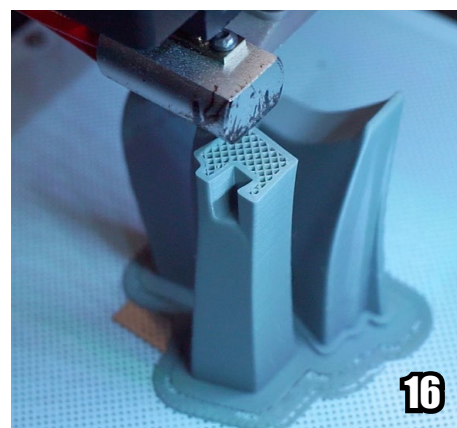
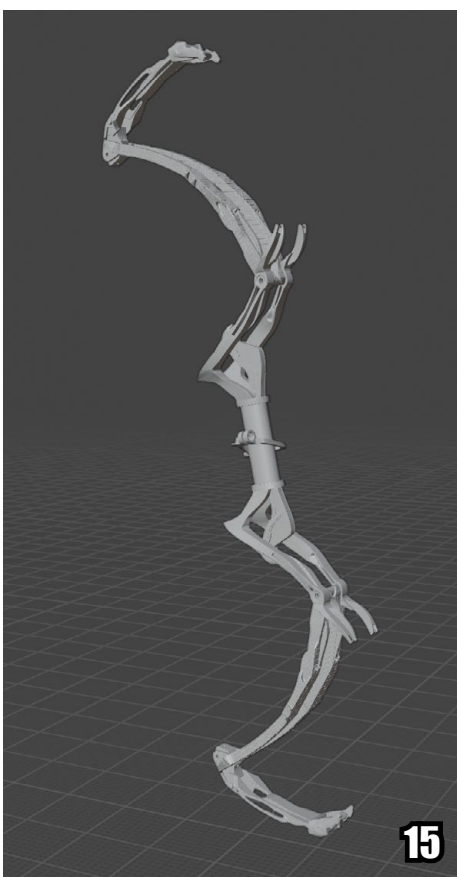
Aloy's Sharpshot bow was one of the most interesting props I've put together so far. The 3D files for it were again commissioned from Jakob. Even though I didn't make the 3D model myself, I believe it's still a great example to show you that figuring out how to print and put together a moving 3D printed prop can be a lot of fun.

Asking for help, collaborating with friends or commissioning a costume from a pro is never something negative. There is no right or wrong way to make a costume. Cosplay is about having fun and being creative. How you get to your goal is completely up to you, so go nuts!

Back when I worked on Aloy, I simply wasn't skilled enough to create such an intricate piece. Jakob however was an incredible artist in Maya. I only provided him some screenshots and video footage of the in-game bow **[14]** and only a few days later he sent me an awesome 3D model to print **[15]**. You can find the model on our website if you're interested.

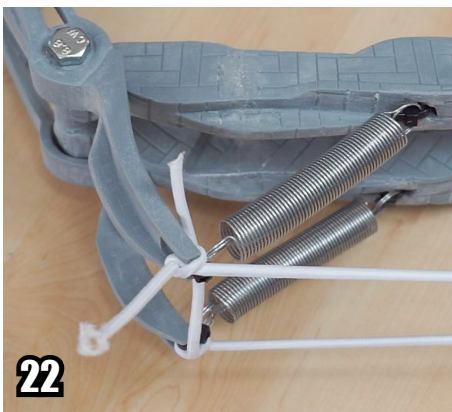
To print the pieces I used ABS and my Zortrax machine **[16]**. I wanted to be able to actually draw the bow, so the parts needed to be as robust as possible. I did a couple of tests with different settings to see what would lead to the best results and finally decided on printing everything with

a thicker outer wall and 50% infill **[16]**. Since the bow was pretty long (120cm in total) and my Zortrax is not very good at printing long parts (warping etc.), I split everything into 10-15cm long parts **[17]**. This however would have led to a lot of glued seams resulting in a weaker overall construction. To get some additional stability, I drilled holes inside both of my pieces and filled them with some ABS slush. Then I placed a small metal rod inside and finally stuck them together **[18-20]**. After letting them all dry for a day, these connections turned out to be super strong. If the bow was to break, it would definitely not be here.





21



22



23



24



25

Once all the main parts were glued, I began sanding them. Like always I did this with a triangle sander and a sanding sponge [21]. You can actually build up your biceps a considerable amount just with sanding, so see this as your workout!

To connect all pieces of the bow, I used strong nuts and bolts, a few tension springs and an elastic string for the pull [22]. The two main

parts of the middle were connected to the grip with a ton of ABS slush [23-24]. Once all dried and assembled, I was able to pull the bow just like in the game, but not actually shoot any arrows. The 3D printed plastic wasn't able to withstand too much tension. I only used a rubber string and springs with enough tension to pull the parts back into position again. Then, a coat of airbrush paint and some

additional beads, strips of cloth and feathers later, the bow was done as well [25]!

I'm pretty good at working with traditional crafting materials, but I don't think I would have been able to make such a cool and functioning bow without 3D printing. As you can see, you only need a couple of projects to really get familiar with the technology. So why not start now?

With the finished bow, all parts of my costume were finally done! So I got dressed and drove to the mountains for a proper photo shoot.

Getting a picture of your finished work is one of the best feelings you can have as a cosplayer. I'm super thankful for all the tools, materials and technologies that help me to make this possible.

3D printing is an amazing new technology that every cosplayer should take advantage of! I hope this book helps you to get a feeling for what's possible. There is a lot more you can do with it that I haven't even touched on in this book.

So go out there and explore! I can't wait to see what you will create!



This is the end! Phew!

I hope I was able to give you a fun and helpful introduction into 3D printing! There is a lot more you can do with your brand new skills, so go out there and experiment! Have fun!

Check out my website for more tutorials, write-ups and videos.

www.kamuicosplay.com

Do you have a question about a costume or prop you want to create? Join our community group on Facebook:

facebook.com/groups/kamuicosplaycommunity

You can always find me on:

facebook.com/kamuicos

instagram.com/kamuicosplay

youtube.com/kamuicosplayofficial

twitter.com/kamuicosplay

And if you like our videos you can support us on:

patreon.com/kamuicosplay

Copyright © 2020 by Svetlana Quindt & Benjamin Schwarz.

All rights reserved. This book or any portion thereof may not be reproduced or used in any manner whatsoever without the express written permission of the publisher except for the use of brief quotations in a book review. The author does not take any responsibility for any harm or damages.

First Release, 2020

Author: Svetlana Quindt, Benjamin Schwarz

Layout: Benjamin Schwarz

Germany

www.kamuicosplay.com